2773

Annals of the Missouri Botanical Garden

Volume XXVIII
1941

With Twenty-nine Plates and Seventy Figures

Published quarterly at Fulton, Missouri, by the Board of Trustees of the Missouri Botanical Garden, St. Louis, Mo.

Entered as second-class matter at the post-office at Fulton, Missouri, under the Act of March 3, 1879.

58200

Annals

of the

Missouri Botanical Garden

A Quarterly Journal containing Scientific Contributions from the Missouri Botanical Garden and the Henry Shaw School of Botany of Washington University in affiliation with the Missouri Botanical Garden.

Information

The ANNALS OF THE MISSOURI BOTANICAL GARDEN appears four times during the calendar year: February, April, September, and November. Four numbers constitute a volume.

Subscription Price.....$6.00 per volume
Single Numbers..... 1.50 each*

Contents of previous issues of the ANNALS OF THE MISSOURI BOTANICAL GARDEN are listed in the Agricultural Index, published by the H. W. Wilson Company.

* Except No. 3 of Vol. 22, price $5.00, and No. 2 of Vol. 25, price $2.50.

WASHINGTON UNIVERSITY
LIBRARY
SCHOOL

ANNALS
OF THE
MISSOURI BOTANICAL GARDEN

TABLE OF CONTENTS

	PAGE
Some Effects of Carcinogens on Yeasts.... ...Carroll W. Dodge, Bertha S. Dodge and George Thomas Johnson	1– 30
A Monograph of the Genus *Parmelia* in North America, North of Mexico..... .....Edward Cain Berry	31–146
Binary Variation in *Tradescantia bracteata* .....Edgar Anderson	147–163
On the Flora of the Frontier Formation of Southwestern Wyoming ....Henry N. Andrews and Cortland S. Pearsall	165–192
The North American Asclepiadaceae. I. Perspective of the Genera..... .....Robert E. Woodson, Jr.	193–244
Two New Asclepiads from the Southwestern United States..... ....Bassett Maguire and Robert E. Woodson, Jr.	245–248
A Preliminary Survey of the Genus *Tripsacum*.....Hugh C. Cutler and Edgar Anderson	249–269
Miscellaneous New Asclepiadaceae and Apocynaceae from tropical America..... .....Robert E. Woodson, Jr.	271–286
Mass Collections—	
The Technique and Use of Mass Collections in Plant Taxonomy.....Edgar Anderson	287–292
Camassia scilloides.....Ralph O. Erickson	293–298
Rubus odoratus and *R. parviflorus*..... .....Norman C. Fassett	299–374
Dichophyllum Moorei and Certain Associated Seeds.....Henry N. Andrews	375–384
A Revision of the North American Species of the Genus *Anisacanthus*.....Stanley H. Hagen	385–408
Contributions toward a Flora of Panama. V. Collections chiefly by Paul H. Allen and by Robert E. Woodson, Jr. and Robert W. Schery ....Robert E. Woodson, Jr. and Robert W. Schery	409–490
The Cytogenetics of *Poa pratensis*..... .....William L. Brown	493–522
General Index to Volume XXVIII.....	523–532

STAFF
OF THE MISSOURI BOTANICAL GARDEN

Director
GEORGE T. MOORE

HERMANN VON SCHRENK,
Pathologist

JESSE M. GREENMAN,
Curator of the Herbarium

CARROLL W. DODGE,
Mycologist

EDGAR ANDERSON,
Geneticist

ROBERT E. WOODSON, JR.
Assistant Curator of the Herbarium

NELL C. HORNER,
Librarian and Editor of Publications

BOARD OF TRUSTEES
OF THE MISSOURI BOTANICAL GARDEN

President
GEORGE C. HITCHCOCK

Vice-President
DANIEL K. CATLIN

Second Vice-President
EUGENE PETTUS

L. RAY CARTER
DUDLEY FRENCH
JOHN S. LEHMANN
GEORGE T. MOORE
A. WESSEL SHAPLEIGH
ETHAN A. H. SHEPLEY

EX-OFFICIO MEMBERS

GEORGE R. THROOP,
Chancellor of Washington University

WILLIAM SCARLETT,
Bishop of the Diocese of Missouri

WILLIAM DEE BECKER,
Mayor of the City of St. Louis

A. H. TIMMERMAN,
President of the Academy of Science of St. Louis

JOHN A. FLEISCHLI,
President of the Board of Education of St. Louis

GERALD ULRICI, *Secretary*

Annals
of the
Missouri Botanical Garden

Vol. 28 FEBRUARY, 1941 No. 1

SOME EFFECTS OF CARCINOGENS ON YEASTS

CARROLL WILLIAM DODGE
Mycologist to the Missouri Botanical Garden
Professor in the Henry Shaw School of Botany of Washington University

BERTHA SANFORD DODGE
Assistant in the Henry Shaw School of Botany of Washington University

AND GEORGE THOMAS JOHNSON
John Simon Guggenheim Memorial Foundation Fellow to Central America
Formerly Lecturer in the Henry Shaw School of Botany of Washington University

With increasing knowledge of the chemistry of cholanthrene and related compounds and their action on mammalian cells, it has seemed desirable to study their effects on organisms with less complex structures and interrelations of parts. Yeasts were thought to be a group of plants of relatively simple organization and to lend themselves to comparatively simple techniques. A preliminary survey of a half dozen genera of increasing complexity of polarity and morphology showed much less effect on morphology than anticipated, therefore subsequent study was confined to two strains of *Saccharomyces ellipsoideus* Reess emend. Hansen, one a champagne strain, the other a Tokay strain. No differences in the physiology of these strains have been detected in our experiments.

We take this opportunity to acknowledge the generous financial assistance of the International Foundation for Cancer Research which has made this study possible; the careful work of Miss Helen Bramsch and of Stanley Hagen, who prepared sections of colonies for our studies of morphology in the early

stages of this work while research assistants; of Edward Cryder, who made most of the haemacytometer counts here reported and who prepared the graphs; and of Dr. Verne F. Goerger, who assisted in microphotography in our preliminary attempts to secure photographic data in connection with population studies. Mrs. Dodge has given much time during the four years of this investigation, while Dr. Johnson has been associated with us during the academic year 1939-40 only. We also wish to express our gratitude to Professors Philip Franklin and Norbert Wiener, of the Massachusetts Institute of Technology, for examining our graphs of population studies and for their assistance in interpreting them; and to Dr. Irving Langmuir and Dr. Katharine B. Blodgett, of the General Electric Company, for suggestions on our work with surface films.

MORPHOLOGY

An old stock culture of *Saccharomyces ellipsoideus,* which had been kept in the ice-box for nearly six months, produced on methyl cholanthrene agar (see p. 4) very curious colonies with a much more complex morphology than in the controls, or anything reported by Píšová ('34). These have been reported in a previous paper (Dodge and Dodge, '37). Repeated attempts to reproduce these curious colonies with their differentiated cortical and giant cells have so far failed.

Some differences in morphology exist between the cultures with a carcinogen, especially benzpyrene, and the controls in *Saccharomyces ellipsoideus* Reess emend. Hansen, *Zymonema capsulatus* Dodge, *Z. dermatitidis* (Gilchrist & Stokes) Dodge, *Mycocandida onychophila* (Poll. & Nann.) Lang. & Tal., and *Castellania tropicalis* (Cast.) Dodge (a strain originally from Castellani's laboratory but perhaps not the original strain), but these differences are much less striking and difficult to describe. That the age of the colony from which the transfer is made and its previous history have some effects on its growth is well known, but so far we have been unable to duplicate our first observations on *S. ellipsoideus* and have turned our attention to fermentation and growth studies.

Growth

Growth as applied to unicellular microorganisms is commonly restricted to multiplication or to increase in individuals, rather than to mere increase in size or differentiation and changes in tissues. Consequently, in any closed system such as a culture, it is essentially a measure of the increase in the number of cells between two instants of observation less the number that have died and disintegrated during the intervening time. In the absence of copulation and sporulation, multiplication is by binary fission, so that theoretically the number of cells should increase by powers of two, an ideal practically never reached in experimental conditions. Before discussing our results, it seems desirable to consider the methods which have been proposed and the sources of error and the interpretation of each method.

Methods and Sources of Error

Media.—In aiming to keep as many environmental and nutritional factors as constant as possible, the ideal medium would be a synthetic one where the concentration and interrelations of each nutrient were known. From time to time such media have been proposed for yeasts, but after trying various formulae, using both inorganic and organic (amino acid) sources of nitrogen, growth was so slow that we reluctantly returned to peptone in spite of its variable composition and the presence of possible growth-promoting substances. We have tried, however, to keep our sources of error as constant as possible by using only two batches of Difco Peptone in all our experiments and we have failed to find any significant difference between the two batches.

Our liquid medium has consisted of 1 per cent Difco Peptone and 2 per cent glucose. To this 2 per cent agar was added for solid media. Saturated aqueous solutions of the carcinogens[1]

[1] The carcinogen crystals were suspended in large flasks of hot distilled water and allowed to stand for several days with occasional shaking and the remaining crystals filtered off through fine filter-paper; the resulting filtrate was considered as a saturated aqueous solution.

were used to dissolve the other ingredients of the medium and distilled water for the controls. The medium has been autoclaved at 15 lb. pressure for 15 minutes. The 1,2,5,6 di-benz-anthracene, benz-pyrene, and methyl cholanthrene[2] have been used in the course of this study, using methyl cholanthrene for most of the experiments. The solubility of carcinogens is very slight, and so far we have been unable to secure a satisfactory method for determining it. We experimented with several monomolecular film methods developed or suggested by Langmuir and others without satisfactory results. The apparent monomolecular film resulting from spreading the methyl cholanthrene dissolved in benzene was evidently not a true monomolecular film, and Dr. D. F. Waugh, of the Department of Zoology of Washington University, after a further study of our material, reports as follows: Attempts to spread methyl cholanthrene, dissolved in benzene, resulted in the formation of a large number of extremely thin platelets which formed at the periphery of the benzene drop. The continuous formation of such platelets caused the water surface, for a considerable distance around the benzene drop, to be covered by a film of methyl cholanthrene which was apparently too thin to show interference colors but which, however, was a number of molecules thick. The effect was similar to that obtained when paraffin, dissolved in benzene, is allowed to spread. No film measurements were attempted.

In the solutions used, these carcinogens appeared to have a

[2] The 1,2,5,6 di-benz-anthracene was secured from the Eastman Kodak Company, the benz-pyrene from F. Hoffmann, Laroche & Co.A.G., Bâle, and the methyl cholanthrene from the International Foundation for Cancer Research. On checking the melting point of our methyl cholanthrene after it stood three years on a laboratory shelf, it was found to melt at 168–174° C. instead of 176–177° C. It was recrystallized by dissolving in hot benzene, cooling and precipitating with cold ether, when it melted at 176–177° C. It was also dissolved in benzene, picric acid dissolved in benzene added, heated with bone black, cooled, filtered, and dissolved in more benzene. Sodium carbonate was added, the flask shaken, filtered, the filtrate washed and recrystallized as above. This also melted at 176–177° C. A sample of methyl cholanthrene was also obtained from the Eastman Kodak Company but as it melted at 171–174° C. it was not used in our experiments. A careful inspection of our data, obtained shortly before and after our purification, revealed no significant differences. Alsopp ('40) has reported alteration of benz-pyrene and 1,2,5,6 di-benz-anthracene when irradiated with ultra violet light.

marked effect on surface tension. When the media were being made up in volumetric flasks and shaken well, the bubbles in the carcinogen media rose rapidly and broke almost instantaneously, while those in the control media persisted as froth for a long time. We have not yet had time to make quantitative measurements of surface tension.

Measurement.—Five methods of measuring growth of microorganisms have been frequently used: diameter of colony, volume, weight (wet or dry), nephelometry, and counting. These will be discussed in this order.

Diameter of Colony.—When an organism grows radially with equal rates in all directions, as is the case with many fungi, this method is rapid and satisfactory. It yielded some satisfactory results with *Zymonema* but was unsatisfactory for the moister colonies, as they were not of uniform height and contour, and was abandoned after preliminary studies.

Volume.—The culture is centrifuged in graduated tubes and the volume of the closely packed cells is recorded. Variations in speed and time of centrifuging, as well as shape of the cells, are possible sources of error. This method has the inherent disadvantage that the cells may be injured in the process, so it does not lend itself readily to following a population over an extended period of time. It also requires a considerable period of time or a relatively large volume of culture media to secure sufficient growth. Since it did not seem to have advantages over dry weight for our purposes, it was not tried.

Weight.—Wet weight, where the organisms are filtered and weighed immediately, has given reasonably consistent results to some investigators (Satava, '18) but seemed to have little except speed to recommend it as compared with dry weight. In some of our preliminary work we filtered by suction, using filter-paper in Gooch crucibles before turning to alundum crucibles. The coarser crucibles (R.A. 98 and R.A. 360) were suitable for filamentous forms, but R.A. 84, with an average pore size considerably smaller than the diameter of our yeast cells, were used in our work with *Saccharomyces ellipsoideus.*

We used Erlenmeyer flasks of 125-ml. capacity, containing 50 ml. of medium inoculated with 3 drops of a uniform suspension from a 5-ml. pipette, and incubated at 25° C. At the end of incubation, the contents were transferred to 50-ml. centrifuge tubes, using the usual precautions of chemical gravimetric technique. After centrifuging long enough to secure a clear supernatant liquid, most of the latter was decanted. Then the yeast, resuspended in the remaining liquid, was poured into the crucible and the tube thoroughly rinsed twice with distilled water. Filtration was by moderate suction (too great suction will crack the crucibles). The crucible was then placed in a drying oven at 70° C. Constant weight was usually reached in 8 hours, although 24 hours was allowed between weighings before the weight was accepted as constant. No attempt was made to read the balance closer than milligrams as it was felt that the next figure would be insignificant. After the final weighing, the crucibles were heated to redness to remove the yeast cells and were stored in a desiccator until we were ready to weigh and use them again. This method gave very consistent results, showing very little error in the technique.

This method is a measure of the total cells, living and dead, but does not include those disintegrated during the time interval. Its chief disadvantage lies in the relatively long time that must elapse between inoculation and the first data as it takes about two days to produce sufficient growth to weigh with much accuracy. As we shall see later, each culture behaves as a separate individual after inoculation, so that the three values of a triplicate set were seldom identical although the variation was not great. If we try to take samples from a larger volume of culture, sampling error is introduced as it is difficult to secure a uniform suspension for sampling and by the very process of sampling the equilibrium of the culture is upset. Also the dry weight varies somewhat with the depth and the area of the surface of medium exposed to the air and hence with the size of the flask and the volume of the medium. Consequently, dry-weight methods are ill adapted to a study of growth rates. A further source of error was introduced in our preliminary experiments as all but *Saccharomyces ellip-*

soideus of the species studied were pathogenic for man; consequently the cultures were sterilized before filtration to avoid accidental infection of the laboratory workers. Since considerable exosmosis is known to follow death, it is probable that exosmosis occurred during the autoclaving and subsequent cooling, probably roughly proportional to the time, a factor hard to control or evaluate accurately; hence our values of dry weight in the preliminary experiments are probably too low. This source of error was not present in our work with *S. ellipsoideus.*

Nephelometry.—This popular method was not used, as it was thought that the great variation in the size of cells and the presence of oil droplets and refractive granules would tend to render it unsuitable for our work. Subsequent studies by Loofbourow and Dwyer ('38) and Richards ('40) seem to support this conclusion.

Census.—Counting of microorganisms has long been the chief source of information of growth rates as changes in population may be observed at frequent intervals. This may be accomplished either by sampling a large culture at intervals or by direct observation of a small closed system under a microscope. In the former, the sample may be dispersed as an inoculum into fresh medium and the resulting colonies counted, a method commonly used with very small organisms such as bacteria which are not easily observed directly. It gives a measure of the total living cells in the volume of sample and, by implication, in the whole culture if sampling and dilution technique is adequate. It does not measure the dead and disintegrated cells which may have formed during the given time interval. Steinhaus and Birkeland ('39) have emphasized the importance of this disintegration in growth studies on *Serratia marcescens* Bizio.

As an alternative, the sample may be placed in a haemacytometer and counted directly over different areas, the counts being averaged and computed for the whole sample and, by implication, for the whole culture. This will give the viable and dead cells but not the disintegrated. Differential counts may

be obtained by staining the dead cells. We used this method while studying the possible cell types of our cultures and attempted to obtain differential counts. In general, the curves roughly parallel the counts in colonies under continuous observation, described in the next paragraph, in spite of the presumably greater oxygen tension of the medium. Both these techniques have inherent sampling errors and changes in equilibrium (much less than in dry-weight determination since the sample subtracts a much smaller volume from the culture).

Finally, we may use a haemacytometer as a micro-culture dish and keep the closed system under theoretically constant observation, counting the cells lying in the volume of medium above the ruled squares. In our work we used standard haemacytometers, taking a sufficient amount of culture medium to fill the counting cell without running into the grooves which were filled with vaseline. A suspension of yeast cells was made and diluted so that the volume used in the culture chamber would contain approximately 1 cell per small square when the cover-slip was lowered into place. No gas bubbles were produced under our experimental conditions. Care was taken to exclude all air bubbles as their expansion and contraction with relatively slight variations in temperature and barometric pressure might cause convection currents. A count was made immediately, and if the cells were found to be unevenly distributed or too many per small square, the culture was washed up and a new one started.

Counts were made at hourly intervals during the working day. It is evident that the observer will need time to sleep and rest his eyes so that a continuous record could not be secured with the observers available. The carcinogens were counted from 8:30 a. m. to 4:30 p. m., and the controls from 9 a. m. to 5 p. m. each day. When there were indications of a sudden change in the slope of the curve toward the end of the day we returned to the laboratory in the evening for additional counts. On Sundays only two or three counts each were made, unless the counts showed considerable change from the previous ones. In the graphs based on these observations, the daytime periods appear as sawteeth of varying

magnitude connected by straight lines. In this manner microcultures were observed more or less continuously up to 46 days. We probably missed many minor peaks and perhaps a few major ones, but our data were the best obtainable with the observers available.

Several difficulties seem to be inherent in this method. Oxygen tension must be lower than in flask cultures, in fact approaching anaerobic conditions. The volume of culture medium available per cell is probably less, although we have no data on this point. The error of counting is negligible until about 60 yeast cells per small square is reached when the cells are closely packed, and it increases as larger counts are obtained, tending to smooth the peaks of the curve more than the depressions. Another source of error lies in the movement of single cells, or rarely pairs of cells, over the line from one square to the next as the rows of small squares counted were not contiguous. While the yeasts are supposed to be nonmotile, several times we observed slow movements of translation similar to those common in some of the Myxophyceae, and a study of photographic records and circumstantial evidence point to other examples. The magnitude of the error is probably not great, as in general the movements would tend to cancel each other. It has been suggested that such movements are due to convection currents, but this seems unlikely since in all observed cases cells very close to the moving cell showed no movement. Such movements were noted on slides which had been resting on the stage of the microscope for 12–18 hours, as well as on those resting on the table beside the microscope. No attempt was made to use a constant-temperature stage, but in every case the slides lay side by side next to the microscope, covered by a small box cover to exclude dust and light when not under actual observation. Therefore, the temperature difference between the two halves of the same slide and between the two methyl cholanthrene cultures on one slide and the controls on the other were very slight, although there was some diurnal variation in the laboratory as well as some seasonal variation after the building was no longer heated, since these experiments covered a period from No-

vember 1938 to the middle of June 1939. These variations probably affected the total counts and consequently the growth rates slightly but less than other factors inherent in the experimental conditions.

The sampling error of the counts is probably low. It was not studied during the direct observation counts, but the photomicrographs showed it to be less than other sources of error in that method (see p. 19), since curves obtained by plotting counts from different rows of four small squares each are parallel for the same microculture. On the other hand, in a preliminary experiment where a small amount of air was included between the vaseline seal and the medium, due to a faulty seal, growth was more rapid (probably owing to greater oxygen tension) and some cells moved into the field, vitiating the experiments.

In our graphs, the points were plotted from the actual counts, and a factor of 50,000 should be used to express cells per cubic millimeter.

An automatic apparatus to produce photomicrographs at regular intervals suggests itself for reducing some of the errors of this method and giving a more continuous record than we have been able to secure by a limited number of observers. Some attempts were made to construct such an apparatus but it presented financial and technical difficulties in the conditions under which we worked. One inherent difficulty of this method is that many cells observed easily by focusing from the upper to the lower surfaces of the layer of liquid between slide and cover slip are missed by the focal plane of the camera, and the images of cells just below and just above the focal plane are so blurred that it is not easy to decide whether buds are attached to the cells or not. Therefore, one is forced to count only the cells in sharp focus. This increases the movement error much more than in direct observation, as well as the inherent difficulty of keeping a camera in the same focus over a period of several weeks while manipulating it to change spools of film, etc. It is probable that, with a specially constructed haemacytometer having a much thinner layer of

medium between slide and cover slip, a very bright light source of the flashing type, and a specially constructed camera, such a method might be devised but it was beyond our means.

Fermentation

Quantitative studies of fermentation fall into two main categories on the basis of determination of carbon dioxide evolved. The gas may be measured volumetrically in a gas burette, applying the usual corrections for temperature and pressure, and the weight computed. The 50 ml. of medium was pipetted into a 125-ml. Erlenmeyer flask, sterilized, and inoculated with three drops of a suspension of *Saccharomyces ellipsoideus*. The flask was attached to the gas burette by means of previously sterilized rubber stoppers and glass tubing. The gas was collected over acidulated water and read at regular intervals, recording temperature and barometric pressure from a mercury barometer hanging near the laboratory desk. After each reading the gas was allowed to escape and the water column returned to zero by means of a leveling bulb. Periods of a rapidly rising barometer complicated the process since they tended to drive the acidulated water back into the culture flask, causing the discontinuance of some experiments earlier than planned. This method has an advantage in allowing more frequent readings than gravimetric methods, with the same degree of accuracy.

In our later work we used gravimetric determination by collecting the gas in potash bulbs or soda-lime tubes and weighing. After eliminating several sources of error in preliminary experiments, we set up trains as follows: soda-lime tube, wash-bottle of distilled water, tube with sterile cotton, large test-tube with 50 ml. of medium, tube with sterile cotton, anhydrous calcium chloride tube, potash bulb or soda-lime tube which was weighed, closed filter flask (to prevent back seepage of water or carbon dioxide to the rest of the system), and water pump. Each time before weighing, the pump was started, and moist, carbon-dioxide-free air was drawn slowly through the system for ten minutes. The soda-lime tubes were weighed quickly

on a chainomatic balance. The tubes containing the medium were sterilized, inoculated, and rapidly attached to the system by previously sterilized rubber stoppers and glass tubing. No contaminations were detected. By the above system the air passing over the medium was moist, free of carbon dioxide and sterile, and the gas reaching the soda-lime tube to be weighed was dry, hence we were not weighing water vapor as well as carbon dioxide. A possible source of error is too rapid aeration, which might remove carbon dioxide from the soda-lime tube before it was completely absorbed. The final, practically constant, weights obtained in our longer experiments seem to support the accuracy of this method. Potash bulbs with strong solutions of sodium hydroxide were early abandoned, as water vapor is lost from the solution during the passage of air through it and in some of our early experiments the potash bulbs actually lost weight. While this method does not lend itself as readily to frequent readings, it is much simpler and involves less computation.

Besides measurement of carbon dioxide evolved, an attempt was made to study the amount of sugar disappearing during the growth of the culture. In our early experiments we determined sugar by the Benedict and Folin-Wu methods. Later we returned to the Bertrand-Shaffer method in which the Fehling's solution is reduced under standard conditions and the precipitate dissolved and titrated with standard potassium permanganate. The end-point of the titration is sharper by this method and gives more satisfactory results. Since other substances beside glucose reduce Fehling's solution, the interpretation of results is sometimes puzzling. In general, the reducing power of the medium disappeared sooner than the cessation of carbon dioxide evolution, although in the final computations the sum of the carbon dioxide, the remaining reducing substance (computed as glucose), and the dry weight (assuming it was all carbohydrate which it certainly was not) accounted for only half to three fourths of the original glucose (determined from the uninoculated tube). The reactions involved need further study before the data are satisfactory.

EXPERIMENTAL DATA

Colony diameter.—This proved a fair measure of growth for filamentous forms but less so for forms with a moist creamy colony. The methyl cholanthrene seems to have depressed

DIAMETER OF COLONIES IN MILLIMETERS

Conc. %	*Z. dermatitidis*			*C. tropicalis*				*M. onychophila* 10 days						*S. ellipsoideus* 20 days				
	10 days	20 days		10 days		20 days												
0	10	25	27	23	24	35		7	8.8	7	2	6		6	6	6.5	5	9
2	4	22	25	20	22	31					2	6					2	5.5
4	4	18	21	10	11	25	28				3	5					2	5
10	7	17	23	13	20	30		4	6	6	3	6		5	5	6	2	4
20	5	23	25	11	13	25	26				6	6	7				2	6
100	7	23	25	12	14	18	20	5	5	5	4	5	7	8	8	8	3	6

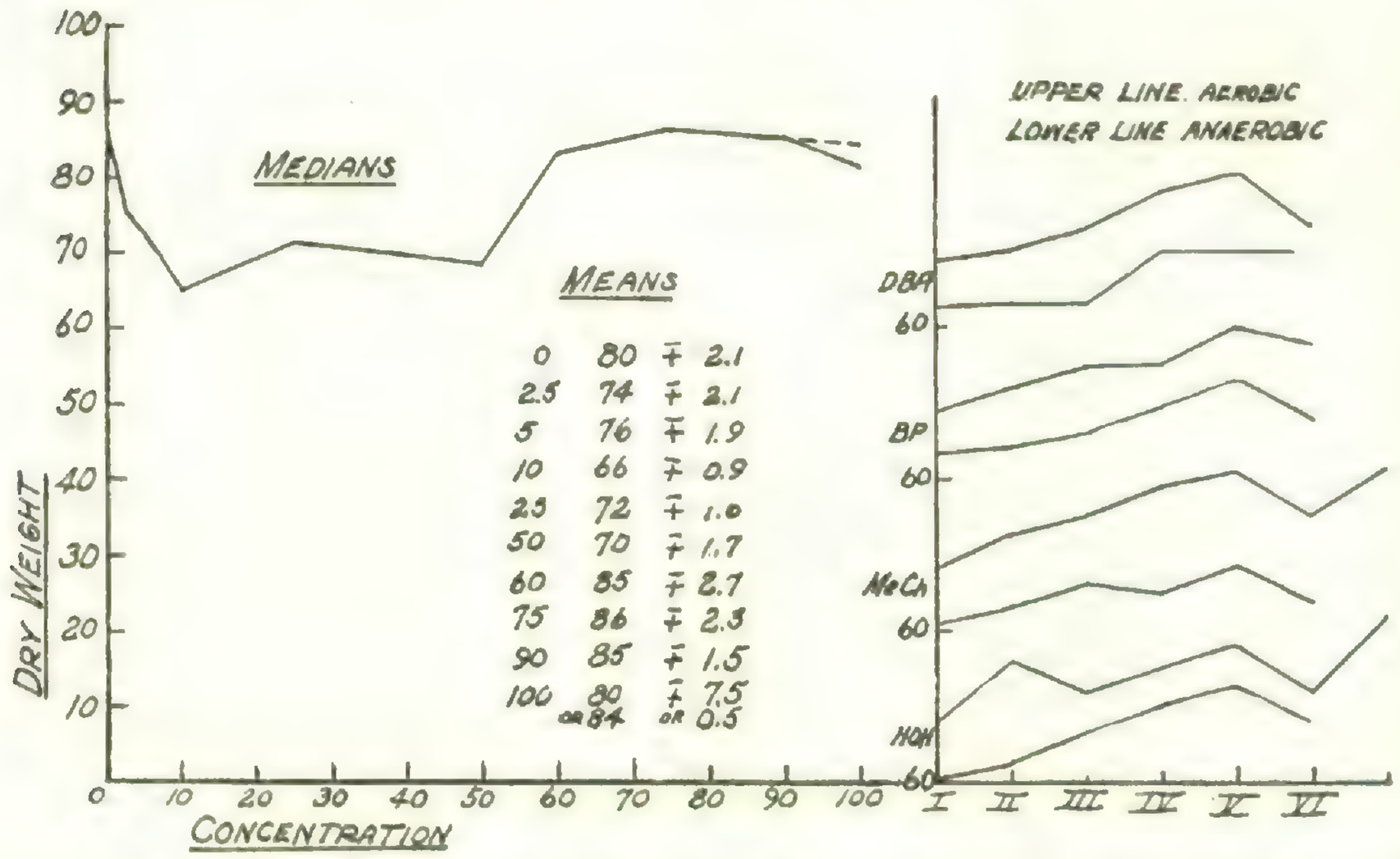
growth of *Castellania tropicalis* and perhaps of *Zymonema dermatitidis* in concentrations above 4 per cent saturation. Dry-weight determinations given below seem to bear this out although the figures are less striking. The variable thickness of the colonies of *Mycocandida onychophila* and *Saccharomyces ellipsoideus* results in seemingly erratic figures for these species.

Dry weight.—In our study of the influence of concentration of carcinogen on dry weight we secured the following results with *Castellania tropicalis* and *Mycocandida onychophila*. It should be remembered that these were our earliest experiments before our technique was perfected and that exosmosis following autoclaving may have affected the results.

DRY WEIGHTS IN MILLIGRAMS

Conc. %	*Castellania tropicalis*							*Mycocandida onychophila*								
	mg. dry weight					Average	Error	mg. dry weight							Average	Error
0	374	359	324			349	8.3	37			27	20		27	20	26.2	1.9
1			254	277	231	254	7.5			75	57	58	75	58	57	65.0	2.8
2	299		254	340	320	303	11.3	39		48	46	55	55	48	46	48.1	1.2
4								34	32								
5	316	315	276	284	318	301	6.6			46	54	23	54	46	23	39.0	3.3
10	285	285	316	321	328	312	6.3			38	21	27	38	27	21	28.7	2.1
20	340	326	307	332	309	323	4.5	93	105	10	61	27	61	27	10	49.1	8.2
50			329	347	335	337	3.1			11	30	8	30	11	8	16.3	3.1
100	191	221	279	339	330	272	19.8	59	69	52	14	29	52	29	14	37.2	5.4

In a subsequent series of experiments with *Saccharomyces ellipsoideus* we found the following results (Graph 1 left):



Graph 1. Left, growth in dry weight at varying concentrations of methyl cholanthrene. Medians plotted, means tabulated. Right, growth in dry weight with three carcinogens and controls. The upper line represents cultures under aerobic conditions, the lower line represents cultures used for fermentation experiments shown in Graph 3, where conditions were essentially anaerobic.

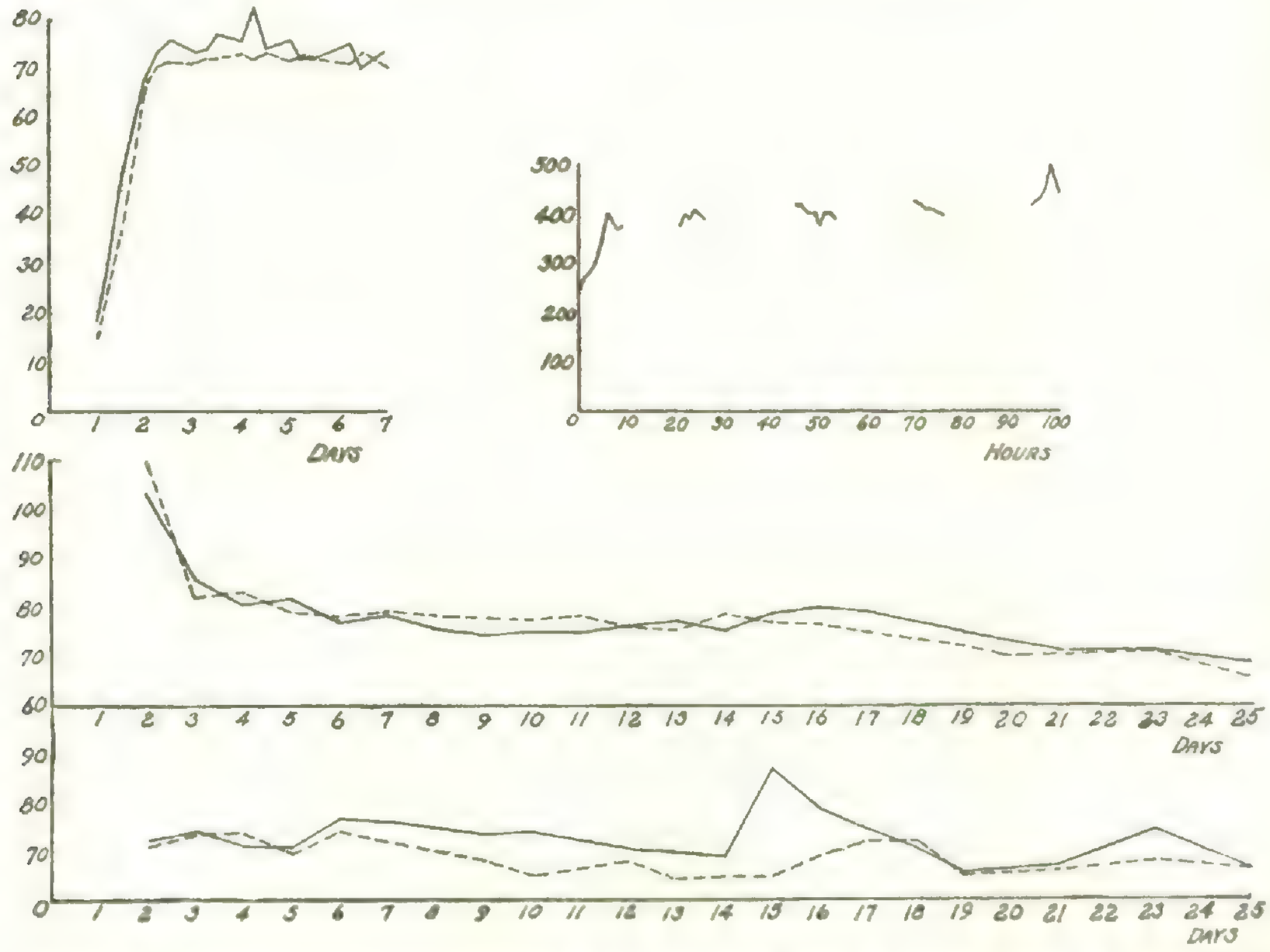
The above graph is based on 5 to 15 determinations for each concentration of the carcinogen (expressed in percentage saturation) with a probable error of ± 0.9–2.7 mg. While the results are not striking they seem to indicate that smaller concentrations depress growth as determined by dry weight over that of the controls, while concentrations over 50 per cent saturation tend to increase it to that of saturation. As the above averages include some of our earliest experiments before we had secured the alundum crucibles, they are probably less accurate than those of our later work. If we exclude these experiments the curves are substantially the same except the value for saturated methyl cholanthrene (shown by dotted line in the graph).

Effect of various carcinogens.—In connection with fermentation experiments, dry weights were determined in quadruplicate for methyl cholanthrene, benz-pyrene, and 1,2,5,6 di-benz-

anthracene and controls on cultures 7 days old. No significant differences were noted, as we obtained the following figures: control 70.8 ± 0.8 mg.; methyl cholanthrene 70.8 ± 0.8 mg.; benz-pyrene 70.8 ± 0.8 mg.; and 1,2,5,6 di-benz-anthracene 70.4 ± 0.8. In the light of our subsequent experiments, it seems likely that the time (7 days) chosen for our experiment was unfortunate, since the controls are the same as the carcinogen, probably due to crossing of curves. It is interesting to note, however, that if each separate dry weight is plotted, the successive weights for methyl cholanthrene are 64.5 ± 1.7, 68.0 ± 0.9, 71.5 ± 2.1, 74.2 ± 1.8, 77.2 ± 1.3 and 72.5 ± 1.5; 1,2,5,6 di-benz-anthracene is slightly aberrant with values 65.7 ± 0.8, 68.2 ± 1.3, 68.7 ± 2.2, 75.6 ± 2.0, 75.5 ± 2.2 and 71.7 ± 1.8 (Graph 1 right). This suggests some sort of cycle of dry weights such as we shall also see in fermentation. In these values the probable errors are higher owing to the averages being for 4 values instead of 24. The range of probable error for controls is ± 0.9–2.6; methyl cholanthrene ± 1.3–2.1; benz-pyrene ± 0.8–2.1; and 1,2,5,6 di-benz-anthracene ± 0.8–2.2 mg. In this series of experiments, half of the values were obtained in cultures freely exposed to the air as in our other dry-weight determinations. The other half were used to determine fermentations by gas volumes which in the conditions of our experiments were under lower oxygen tension and high carbon-dioxide tension approaching anaerobic conditions. In the latter the absolute amounts were about 10 per cent less dry weight and more variable in successive experiments. The probable error of the determinations ranged from 0 (when two observed values were identical) to ± 1.2 mg.

Several long-time experiments were undertaken to attempt to follow changes in dry weight during the stationary and decline phases of cultures. Dry-weight determinations do not lend themselves readily to a study of the lag and the logarithmic phases. The differences between methyl cholanthrene cultures and controls are slight. As the curve levels off, it begins to descend slowly by a series of small sawteeth, similar to those of population counts but much less in extent, with an occasional high peak. While in general the curve for methyl

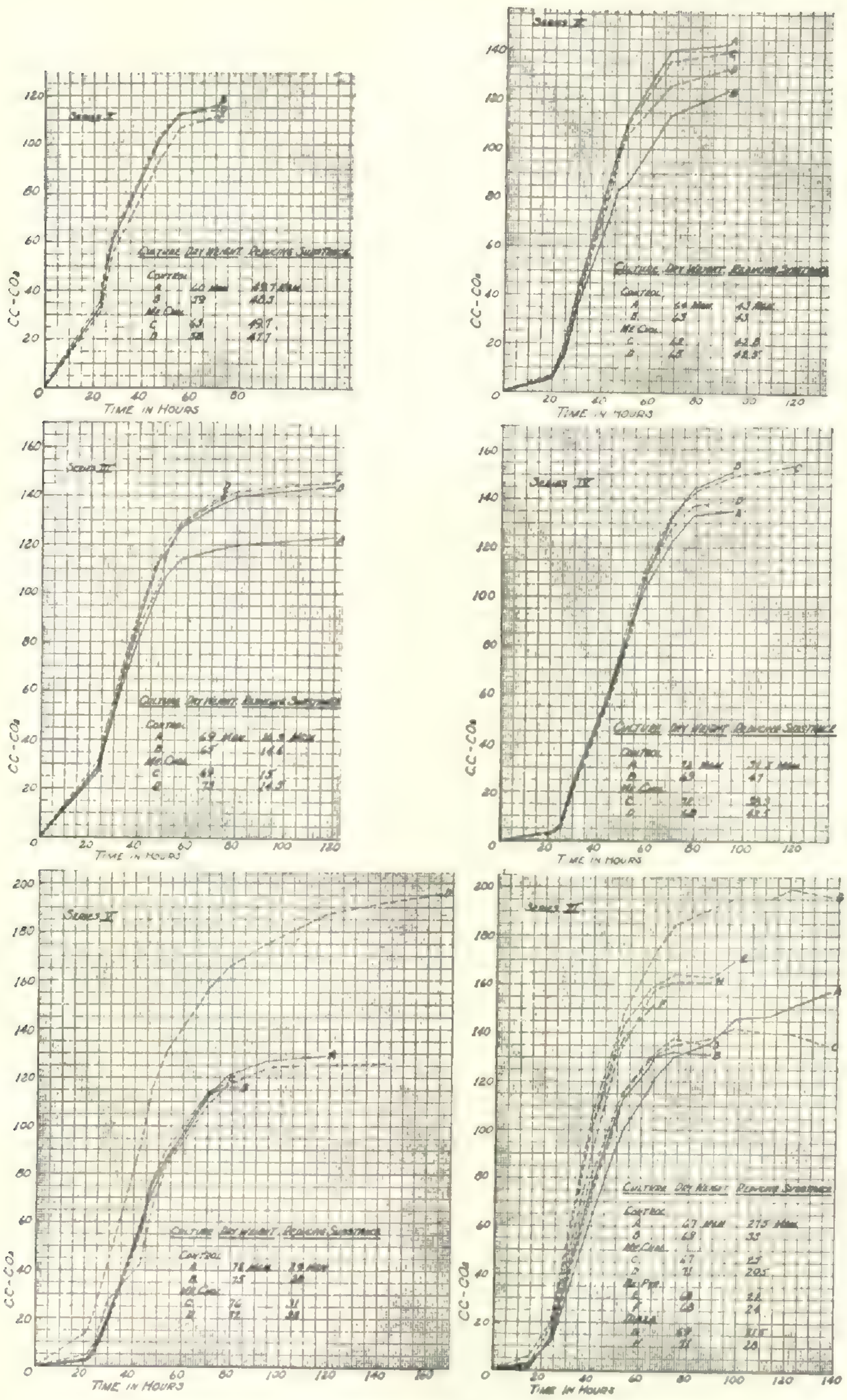
cholanthrene is slightly below that of the control, the curves frequently cross. An average of 118 determinations from the second to the twenty-fifth day gives a dry weight of 80.1 for the controls and 78.1 for the methyl cholanthrene cultures, with a probable error much less than ± 1 mg. While only a single experiment was carried to 130 days, the results are similar to the above series carried only to 25 days (Graph 2).



Graph 2. Growth in dry weights for first 25 days in long-term experiments. Upper right, a typical population curve with large inoculum. Note nearly complete absence of lag phase.

FERMENTATION

In our first experiments we attempted to study the effects of methyl cholanthrene, benz-pyrene and 1,2,5,6 di-benz-anthracene. Six successive series were run and the volumes of carbon dioxide recorded. When the corrected volumes are plotted against time, in series I–IV (Graph 3) we note a continual increase in the amount of gas evolved, the close proximity of the curves of carcinogen and control, and the rising dry weights in each successive series. In series V the total carbon dioxide is below that of series IV in the control and methyl cholanthrene, while that of 1,2,5,6 di-benz-anthracene is far ahead.



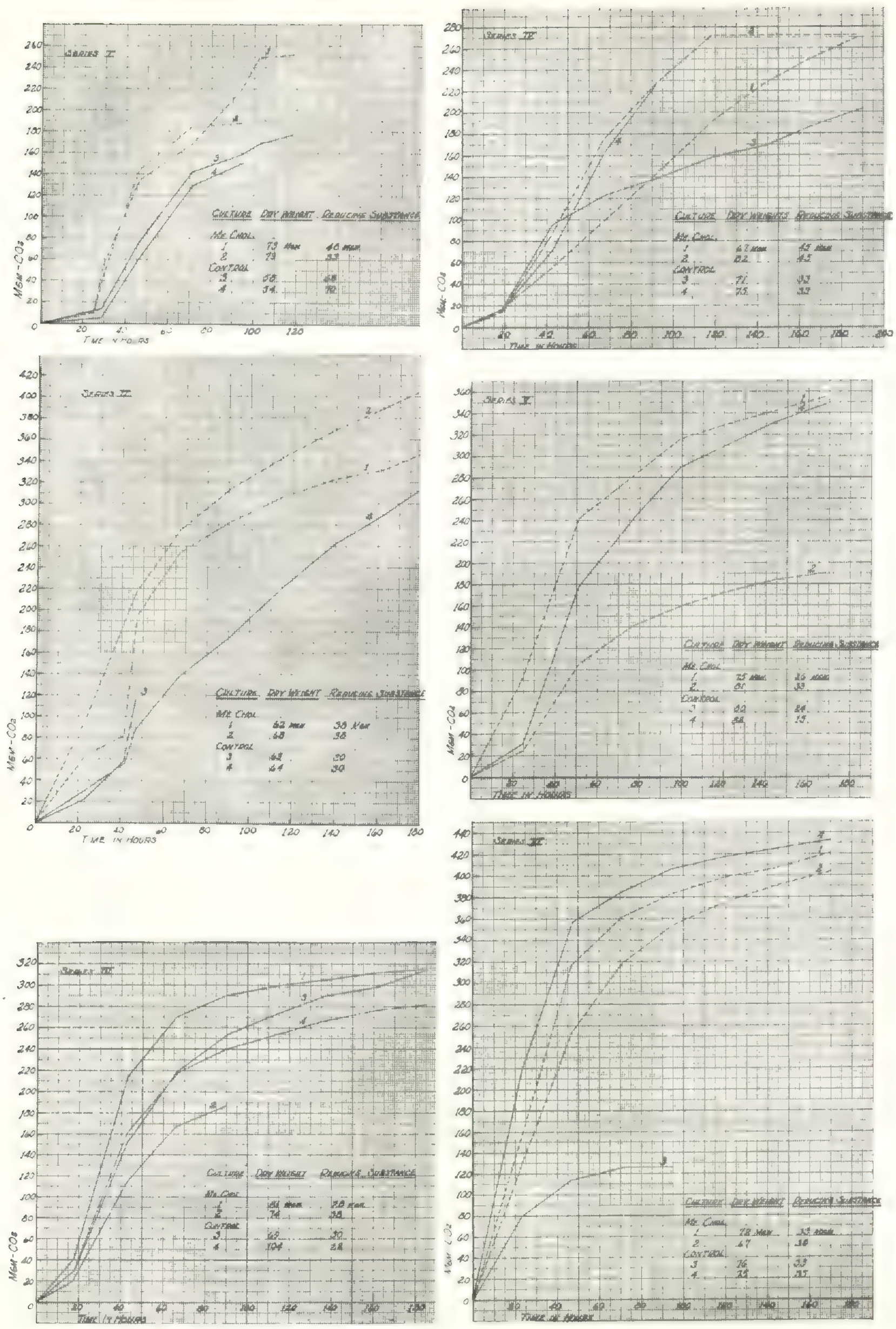
Graph 3. Fermentation. Carbon-dioxide volumes plotted against time.

In Series VI the control curve becomes irregular and both benz-pyrene and 1,2,5,6 di-benz-anthracene show great increases over series V. From our later experience, the irregularity of the control curve suggests that had we continued a seventh series we would have found the yeast much more susceptible to the influence of the carcinogens.

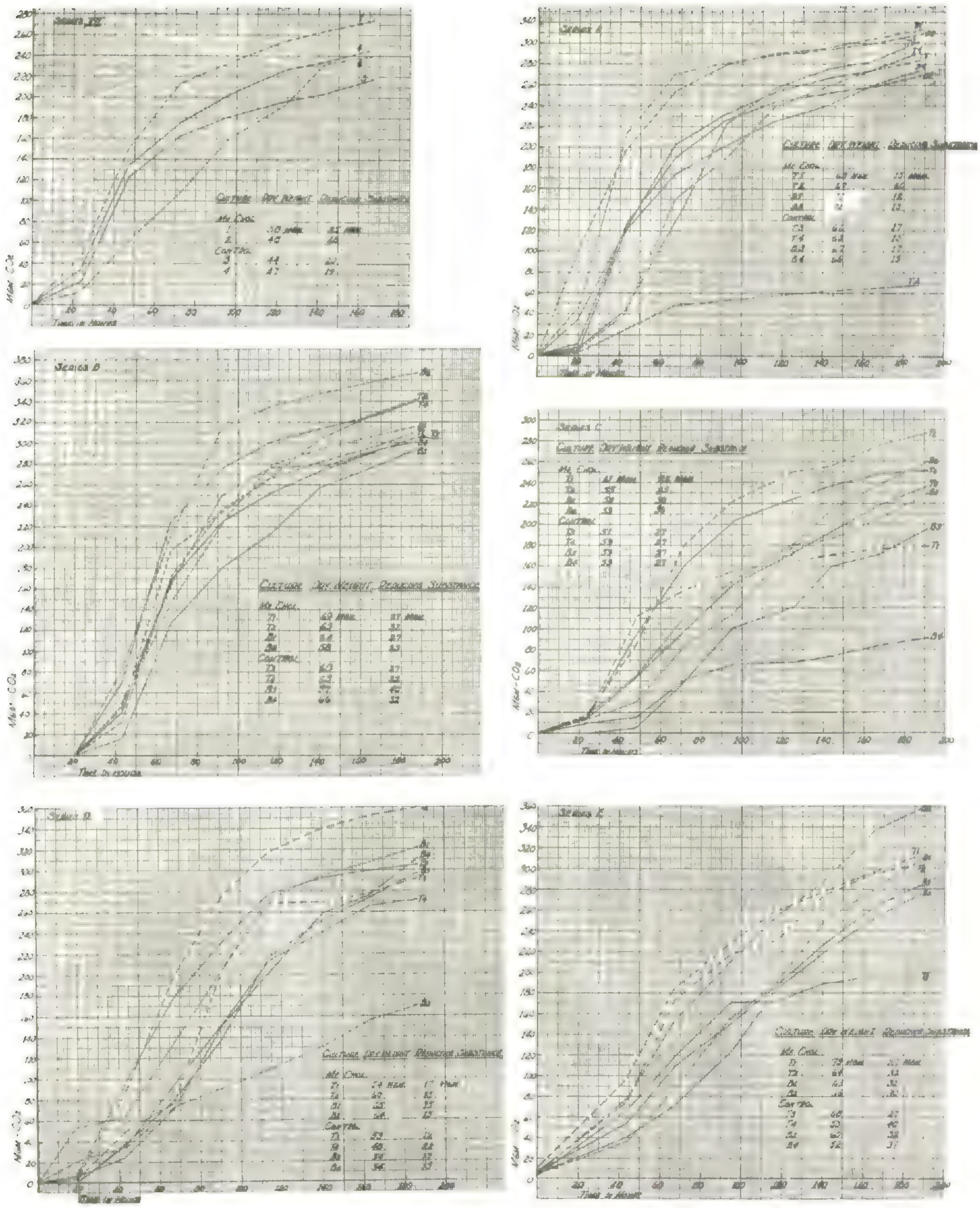
An attempt was made to determine the reducing power of the solutions at the end of the experiments, hoping to check the carbon dioxide evolved against the decrease in glucose. The percentages for the different series were as follows for the controls: I, 38.1; II, 40; III, 41.5; IV, 49; V, 48; VI, 45. Therefore it seems probable that part of the glucose is synthesized into a more complex carbohydrate (without or with part of the peptone) which remains in solution but which has lost its reducing power.

Since difficulties were experienced with negative pressures toward the close of the experiments, we turned to gravimetric determinations during the next experiments and confined our attention to methyl cholanthrene (Graphs 4, 5 upper left). The weights of carbon dioxide were higher in seven consecutive series and consequently the proportion of the original glucose accounted for was higher, ranging from 27 to 55 per cent for controls and 29 to 57 per cent for methyl cholanthrene, yet there was no conspicuous correlation between dry weights, weight of carbon dioxide, and the amount of glucose left. Since from other observations we had noted some differences in size and shape of cells, it seemed possible that the different types of cells might behave differently, and we attempted a partial separation by their different sedimentation rates (Satava, '18, further studied by Nielsen, '37).

A 50-ml. culture to be used for inoculum was centrifuged until the cells, packed in the bottom, differed from those remaining in suspension, as shown in haemacytometer counts. One of the samples was then diluted until haemacytometer counts showed approximately the same number of cells per unit volume. These were used as an inoculum for Series A–G, top; while the sediment was used for another series (A–G bottom, Graphs 5, 6 left). A similar separation was also



Graph 4. Fermentation. Another series with weights of carbon dioxide plotted against time. The last member of this series shown on upper left of Graph 5.



Graph 5. Fermentation. Upper left, continuation of series on Graph 4. Series A-E, contrast of fermentation by cells from the supernatant (T) and sediment (B) in fractional centrifugation studies.

attempted by natural selection with Gorodkova solution cultures and compared with our usual medium (Series H, Graph 6 upper right) and finally a comparison of the top (T_1, T_3) and bottom (B_2, B_4) cells with the whole (S_1, S_2, S_3, S_4) culture (Series I, Graph 6 lower right). For discussion of the morphological types found, see p. 25).

With both the top and bottom cells the controls show less dry weight and leave more glucose in solution at the end of the experiment than in the methyl cholanthrene. The top cells of the controls show more of the glucose accounted for and slightly greater total fermentation than the methyl cholanthrene cultures, while the bottom cells of the controls show less glucose accounted for and slightly less fermentation. Since the fermentation was allowed to go to completion, it would be expected that the difference in total fermentation would not be conspicuous. If we examine the amount at about 90 hours, when the curve begins to level off, the differences are more conspicuous, especially in the bottom methyl cholanthrene. As we shall see later, there was no conspicuous correlation between these data and the various types of cells present. It seems probable that such relations exist but it will take more refined methods of classifying the morphology of cell types to show it clearly.

Population Studies

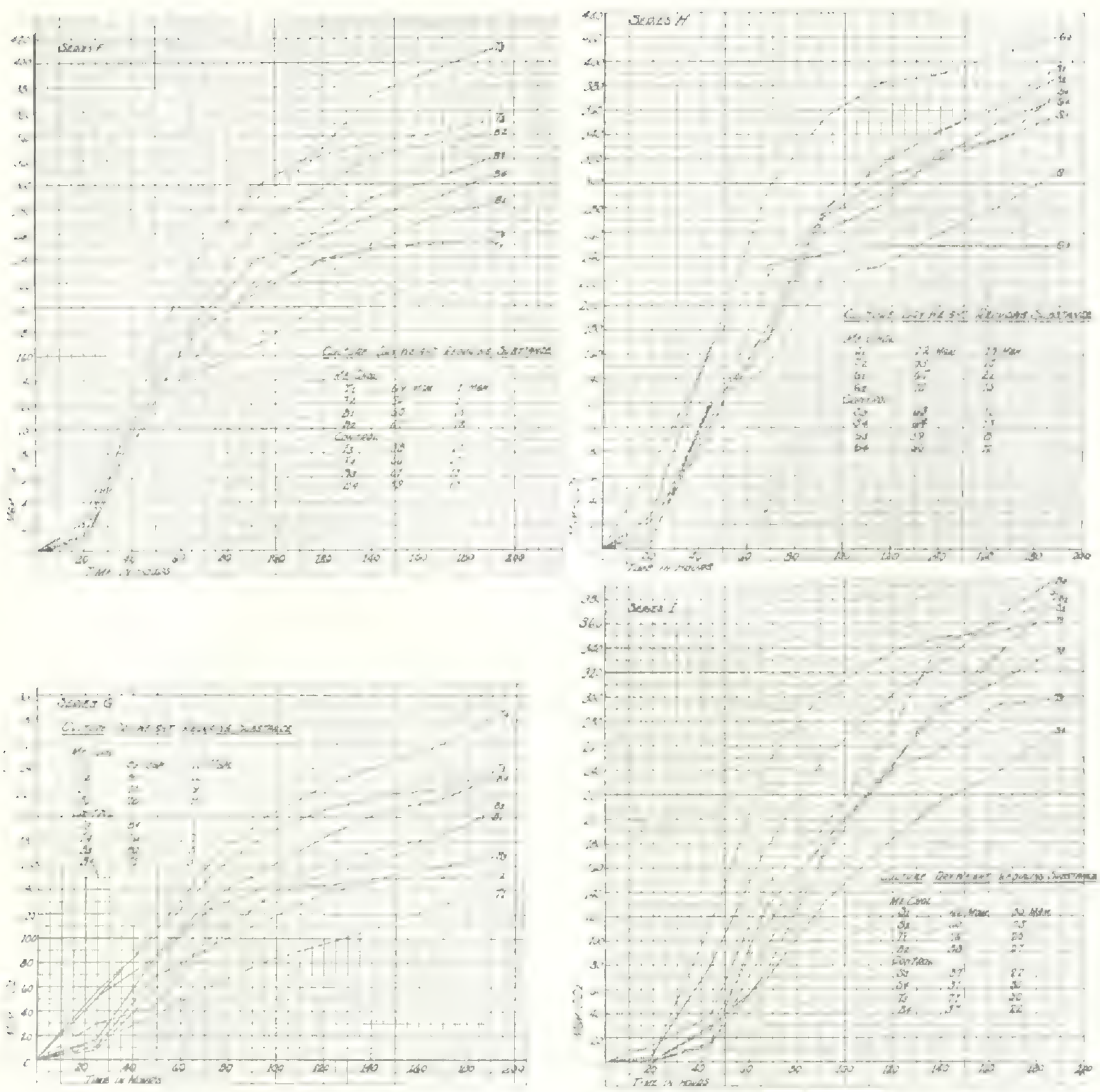
In order to test the validity of our population counts, a given large square of the haemacytometer was photographed at 4–6-hour intervals for 150 hours and the resulting negatives were used to count the cells in each small square. Graph 7 left was based on the sum of rows 1 and 3 and of rows 2 and 4 to compare with our previous counts where we counted rows 1 and 3 in each of two adjacent large squares.

The curves are closely parallel considering the difficulty of keeping the microscope at the same focus over a long period of time. This fact should rule out serious error due to the movement of cells from one square to another, and points to a single stimulus or group of interrelated stimuli which act on the whole population within the time intervals between photographs. As

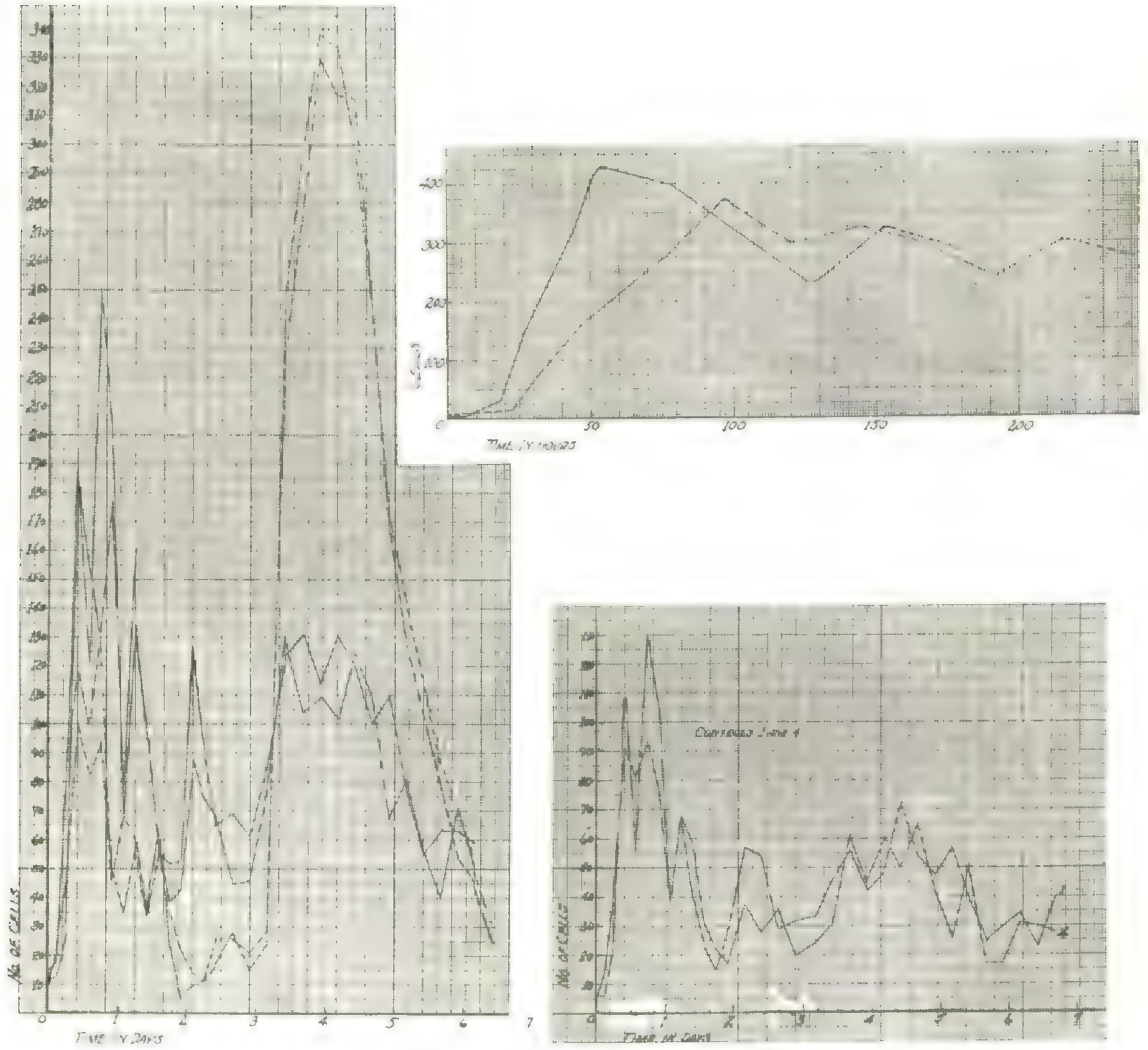
a further check upon our method we plotted, from a single field of our haemacytometer, the hourly counts selected at random from our mass of data and again found the curves parallel. In this case rows 1 and 3 in two adjacent large squares were counted. If we plot the average of rows 1 and 3 from each large square the parallelism is closer than if we compare the two rows farther apart, i.e., row 1 of the upper large square with row 4 of the lower large square (Graph 7 lower right), suggesting a stimulus diffusing from a focus which takes more than an hour to reach its maximum effect. Since these curves are extremely irregular with similar phase throughout the community, it is clear that there is some factor or group of interrelated factors acting uniformly upon the whole community.

In the course of our experiments 36 cultures were counted for varying periods of time. If we average all our counts where there were at least 10 data available at each hourly interval, we have curves approximating the classical growth curve, since most of the fluctuations are averaged out (Graph 7 upper right). The control curve shows a lag of 12–15 hours, a logarithmic phase of about 30 hours and a decline phase of at least 60 hours, followed by a smaller secondary rise of at least 60 hours. The slope of the secondary rise is less steep and the total counts are considerably less. Richards ('32, '40) has studied this secondary rise in much detail, using *Saccharomyces cerevisiae*. Our data parallel that of Richards rather closely considering the differences of medium and species of yeast.

Similarly, the average curve of the carcinogen is smooth, showing a lag of 20–22 hours, a logarithmic phase of about 80 hours, a short decline of about 20 hours, and secondary and tertiary rises of about 25 hours with declines of about the same length. The rises are less steep and the height of the first peak is less, but the decline phase tends to remain at a much higher level than in the control. Fishbein, Weaver and Scherago, in a paper read at the annual meeting of the Society of American Bacteriologists as this paper was in press, working with *Escherichia coli* and 1,2,5,6 di-benz-anthracene, showed essen-



Graph 6. Fermentation. Left (Series F, G), continuation of series on Graph 5. Series H, comparison of our standard medium with inoculum from Gorodkova solution with its higher percentage of elongate cells. Series I, comparison of fermentation by uncentrifuged inoculum with the supernatant (T) and sediment (B) from fractional centrifugation.



Graph 7. Lower graphs, cell counts from photographs at 4–6-hour intervals. **Left, sums of rows 1 and 3 plotted against rows 2 and 4 as in Graph 8 of haemacytometer counts.** Note parallelism of curves. Right, controls only, row 1 plotted **against row 4. Upper right, average curve for all curves shown on Graph 8.**

tially the same type of curves, although working with bacteria and colloidal suspensions of the carcinogen.

In three cases where we started with higher inocula (about 200 cells per field, Graph 8 upper and extreme right, Graph 2 upper right) the curves rise, with no appreciable lag, to a much lower peak and level off for the first 100 hours in a long stationary phase (senescent phase of Steinhaus and Birkeland). This curve somewhat resembles that reported by Hopper and Clapp ('39) and closely that of Fishbein, Weaver and Scherago, mentioned above, when they used large inocula. These results agree essentially with those found in dry weights and fermentations where also we were dealing with large inocula. There is no appreciable difference in the slope of the curves between cultures grown in the haemacytometer and those grown in test-tubes and sampled for counting.

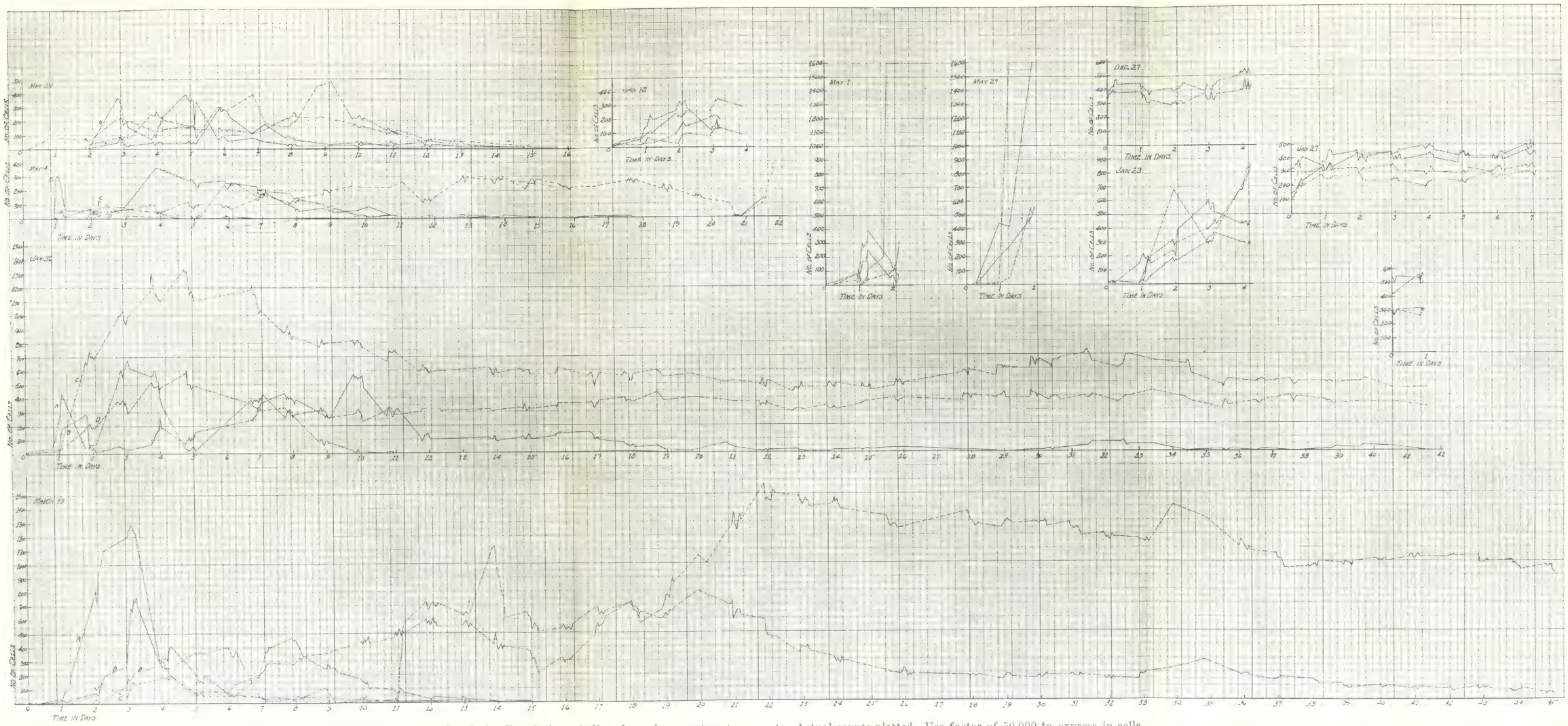
Averages, however, often conceal some important data. If we examine the curves of cultures in the two fields of the haemacytometer having the same medium and inoculated with approximately the same number of cells from the same suspension and subjected to the same environmental conditions but not physically connected, we find that they rapidly get out of phase and vary quite independently. If the fluctuations of the counts were due to genetic or to other factors inherent in the inoculum or factors of the external environment of the culture, we should expect the fluctuations to occur simultaneously in the separate cultures. This is not the case, and we may safely conclude that the fluctuations in the populations, resulting from division and disintegration of cells, are not the result of inherent variations in the inoculum nor in the external environment of the culture but rather the result of stimuli arising within the culture itself. Steinhaus and Birkeland ('39) probably observed similar fluctuations in *Serratia marcescens* Bizio but they present only average curves. They also emphasize the importance of disintegration of cells and the reutilization of the nutrients thus freed during the senescent phase.

Our curves (Graph 8) show a high degree of randomness with large fluctuations compared to the mean, such as one encounters in curves in stock-market reports where the deci-

sions of relatively few individuals in the community profoundly affect the curve of prices of stocks. Applying the usual tests, we find that our curves are neither those of random distribution nor of Brownian movement. We should hardly expect random distribution since each new cell originates from a previous cell at a definite point in time and space, and from our fragmentary observations when light conditions were especially favorable, it seems to be included in a thin gelified sheath for some time after it has severed observable protoplasmic connection with the parent cell. While movement of single cells has been noted, presumably after the sheath has disintegrated, it has none of the characteristics of Brownian movement.

If the phenomena causing the fluctuations were mass effect due to large numbers of cells, we should expect large smooth sweeps with a small degree of randomness. In a large culture such as we used in determining dry weights and fermentation, we find this type of curve, since the small individual fluctuations arising at different points in time and space rapidly average out and give a relatively smooth curve with only the extremely large fluctuations evident. We have already seen this when we averaged all our individual curves where at least 10 counts for a given hour were available (Graph 7).

In the light of our experiments, it seems probable that we are not dealing with individuals in a community, but that the community as a whole represents a liquid tissue in which the cells have lost their geometric arrangement in space but have still retained some differentiation in function, and that certain cells are differentiated to secrete some growth hormone. Perhaps this unlooked-for result should have been expected, since from studies of comparative morphology and phylogeny of the yeasts we have a definite degeneration series from organisms with very complex morphology and life cycles to the "unicellular" condition in *Saccharomyces* (Dodge, '35). The presence and persistence of the gelified sheath point in this direction but need much more study before their meanings are clear. We also need more continuous observation by some method which would give a continuous record of the fluctuation in number of cells, paralleled by frequent microscopic examina-



Graph 8. Population studies from haemacytometer counts. Actual counts plotted. Use factor of 50,000 to express in cells per cubic millimeter. Graph of January 30, a single experiment with benz-pyrene; all the others with methyl cholanthrene. Broken lines, curves of carcinogens; solid lines, controls.

tions to locate the few individuals which are producing the fluctuation and to describe their morphology.

If we examine the individual fluctuations, we also note that very rapid "birth" rates are followed by nearly as rapid disintegration rates, so that the curve for a single fluctuation is nearly symmetrical. The very rapid disintegration of cells from one hour to the next has been evident in most of our work and seems to have been overlooked by many workers. This rapid disintegration apparently sets free nutrients which may be used again to allow more growth, for if we examine the bottoms of the depressions we find that the curves are again approximately symmetrical, although the peak reached after a depression is usually lower than the previous peak.

When we examine the curves for methyl cholanthrene we find essentially similar conditions. In general, the initial lag period is longer and the peaks are broader as well as higher. It would appear that the stimulus is more continuously applied in addition to that of the postulated hormone secreted by individual cells. The larger numbers of cells usually present after the first rise would also tend to smooth the curves, as there would be a greater chance of "hormone"-secreting cells being present. If the methyl cholanthrene is a constantly acting stimulus, it would tend to mask the rapid disintegration rates, thus resulting in increased growth rates during the logarithmic phase and apparently decreased disintegration rates. Since this does not appear to be the case, it is probable that the methyl cholanthrene stimulates cells to divide that ordinarily would not do so, apparently injured or senescent cells.

If a diffusible chemical impulse were the only factor, and all cells receiving the stimulation divided immediately, the peaks would be much greater and would reach approximately the same heights where the initial cultures contained approximately the same number of cells. Hence it seems probable that at any one time only a portion of the cells are sensitive to stimulation. If such cell sensitivity were merely a function of age, the curves would rise in continuing peaks as all the cells came of suitable age, which is not the case. The differences in height, number, and time of appearance of the peaks suggest rather

a few sensitive cells which form centers of growth. The height may be determined by the number of sensitive cells and whether such cells are in our immediate field of vision. Their age may be important in determining the response to the stimulus. Where there are very few sensitive cells, as in a small inoculum, the peak is conspicuous and sharp; where more of these cells are present, the peaks appear to be made up of a succession of sawteeth, less sharp as more sensitive cells are present until in large inocula we reach a broad and smooth curve similar to the classical growth curve. The other cells, which are present in far greater numbers than the sensitive cells, may be regarded as somatic cells. It is not clear at present whether they die slowly or persist until their function is taken over by a new crop of somatic cells.

That these cells are merely reproductive cells which function without a definite stimulus is untenable, since if there were no diffusible stimulus there would be no parallelism between curves plotted from different regions of the same culture. We would have only isolated centers where multiplication and disintegration would start quite independently, which is not the case.

There is also an effect traceable to the history of the culture evident through a series of transfers, since otherwise there would not be as much parallelism between subcultures transferred on the same day. Despite differences great enough to indicate that they vary independently, there is sufficient parallelism in population counts, and even more in dry weights and fermentation data, that duplicates, i.e., contemporaneous subcultures, are definitely more alike than cultures from the same stock culture made days or weeks apart.

There is still another complicating factor. Evidence is accumulating that there is a definite cycle of fluctuations in the physiology of the cultures. This cycle appears to be a long one, and while frequent transfer may somewhat modify the time it does not alter the fundamental process. It appears that instead of being a strictly unicellular organism, completing its life history in a comparatively short time, the yeast is a complex organism in which the whole culture behaves as an indi-

vidual, a liquid tissue with a much longer life history which the addition of fresh nutrient (transfer, which is similar to tissue cultures and cuttings of the higher plants) may alter only in a minor way. Taking long enough periods we may reproduce dry weights and fermentations very closely. Reappearance of very high dry weights (over 90 mg. under our standard conditions) in approximately six-month periods suggests this as an approximation for the cycle of our stock culture.

Cell Differentiation

Study of cells of individual cultures reveals a fairly constant morphology during the logarithmic phase. The inoculum, if taken from an actively growing 24-hour culture, consists of comparatively small, homogeneous cells. If inoculated from older cultures this form is also assumed during the lag phase and remains homogeneous during a portion of the logarithmic phase. Small vacuoles appear and granules of reserve food become visible in the cytoplasm. In still older cultures, the vacuoles become large and the granules more numerous, there being apparently little correlation as to whether the granules are located inside or outside of the vacuole itself. Elongate cells rarely occur in young cultures but are relatively more abundant as the culture ages, although their number is seldom large. In our medium, the elongate cells seem to revert easily to the spherical form but those isolated by a micromanipulator and transferred to fresh medium frequently retain the elongate form for several generations. Although cultures of the same age are relatively constant in morphology during the early stages after transfer, the morphology is progressively more variable in older cultures, perhaps due to different disintegration rates.

In this preliminary study we recorded the cell types as percentages of large spheres, small spheres, and elongate cells. We also recorded the spherical cells with buds, the elongate cells with buds, cells with large vacuoles with or without reserve materials, and shadow cells. In our experiments with fractional centrifugation we recorded the following:

SAMPLE OF SUPERNATANT (''TOP'')

Series	Spheres		Elongate Cells	Buds		Vacuolate		Shadow Cells
	Large	Small		Spheres	Elongate	Without Reserves	With Reserves	
A	13	78	9	13	7	6	0	0
B	7	82	11	11	8	4	0	0
C	9	81	10	14	8	2	0	2
D	20	73	7	20	5	0	0	5
E	10	80	10	15	4	2	0	1
F	18	67	15	9	6	6	3	4
G	32	59	9	12	4	4	0	7
Average								
Inocula	15.6	74.3	10.1	13.4	6	3.4	0.4	2.7
Control	42.1	53.3	3.6	18.7	2	9.0	4	0.8
Me. Chol.	42.1	54	3.9	18.4	2.4	9.9	4.5	0.2

SAMPLE OF SEDIMENT (''BOTTOM'')

A	37	57	6	28	1	18	2	0
B	46	49	4	32	0	19	3	0
C	47	50	3	30	0	11	11	0
D	49	46	5	28	4	15	9	2
E	42	56	2	23	0	7	0	0
F	61	36	3	20	1	9	3	0
G	58	40	2	18	0	7	10	0
Average								
Inocula	48.6	47.7	3.6	25.5	0.9	12.3	5.4	0.3
Control	43.8	52.1	3.3	17.4	1.7	7.1	3.4	0.3
Me. Chol.	42.5	53.8	3.6	21.0	2.2	8.4	3.8	0.4

It is apparent that the crude fractionation we used did not completely separate the cell types as we classified them, although a larger proportion of large spheres, vacuolate cells, and buds was found in the sediment and more elongate cells and shadow cells remained in the supernatant. No clear correlation has been evident between the cell types, as we have classified them, and physiological activity. At the end of the experiments, the cultures inoculated with either top or bottom cells approach the bottom types of the inocula obtained by fractional centrifugation, as shown in the next to last line in the above tables. The methyl cholanthrene cultures consistently show more elongate and vacuolated cells at the close of the experiments (last lines of the above tables).

We also tried some media for possible selective action with reference to our cell types. Four solutions were inoculated with

two drops of a uniform suspension of a 24-hour culture which had been transferred every 24 hours for several days previous to this inoculation. From these solutions the yeasts were transferred to fresh media every four days. Examinations were made after the third transfer. Sabouraud's solution (our usual medium) gave results similar to those we had obtained previously; Williams' and Cohn's solutions favored the development of colonial forms of varied morphology; Gorodkova's solution gave a much larger number of elongate cells with more budding of these cells. Since these differences were greater than we had secured by fractional centrifugation, we attempted to compare growth in Gorodkova solution with that in the Sabouraud culture as a control. Four-day cultures of this third transfer to fresh media were shaken to form a uniform suspension and the cell types and number of cells per ml. were recorded. A portion was then removed from each culture, placed in sterile flasks, and diluted until the number of cells in each was approximately equal as determined by another count. During the dilution process the cultures from which the source of inoculum was taken were filtered through a Berkfeld filter and a portion of each filtrate equal to the amount taken to make the stock cultures was added to the other culture, so that the final results were strictly comparable, not only as to approximate number of cells, but also the component nutrients were identical (Series H). The inoculum and final results contained the following cell types:

SERIES H

Cell types	Inoculum		End of Experiment							
	G	S	Gorodkova				Sabouraud			
			Me. Chol.		Control		Me. Chol.		Control	
Large spheres	7	28	32	36	36	31	28	41	32	24
Small spheres	68	67	60	60	57	65	70	57	64	74
Elongate cells	25	5	8	4	7	4	2	2	4	2
Spheres with buds	43	12	18	14	21	12	18	24	23	18
Elongate cells with buds	21	4	3	3	5	2	0	0	2	2
Cells with large vacuoles	2	4	10	9	7	9	7	4	8	7
Vacuolate cells with reserves	0	2	4	0	0	0	3	3	5	2
Shadow cells	0	0	0	0	0	0	0	0	0	0

No correlation with cell types was noted beyond slightly more elongate cells persisting from the Gorodkova inoculum.

Finally we compared flasks inoculated with a whole culture with the top and bottom fractions obtained by fractional centrifugation. (Series I).

SERIES I

Cell types	Inoculum			End of Experiment							
	Top	Bottom	Whole	Me. Chol.				Control			
				T_1	B_2	S_1	S_2	T_3	B_4	S_3	S_4
Large spheres	12	38	24	18	32	41	29	24	28	38	35
Small spheres	80	60	69	80	64	54	69	75	70	61	63
Elongate cells	8	2	7	2	4	5	2	1	2	1	2
Spheres with buds	12	10	20	16	28	17	14	13	21	23	17
Elongate cells with buds	5	2	3	2	6	2	0	0	2	1	0
Cells with large vacuoles	2	10	7	2	14	11	14	8	9	9	6
Vacuolate cells with reserves	0	7	4	0	6	7	4	3	3	4	2
Shadow cells	2	0	2	0	0	0	0	0	0	1	0

We found that the culture as a whole was much closer to the bottom fraction in dry weight while closer to the top fraction in fermentation. Evidently something has happened in centrifugation as the fermentation curves in methyl cholanthrene rise more steeply, especially the curve of the top fraction; the dry weight is conspicuously higher in both methyl cholanthrene and control. Further work will be necessary to decide whether this is due to mere separation of cells from the gelified sheath or to some type of injury.

SUMMARY

Studies of dry weight produced under standard conditions, and population studies with large inocula, revealed only small differences between cultures with methyl cholanthrene and the controls. The methyl-cholanthrene cultures tended to have a slightly longer lag phase and slightly less dry weight.

Studies of population by various methods of counting, using smaller inocula, show a much longer lag phase, a gentler slope in the first logarithmic phase, and higher and more sustained peaks in the decline phase in cultures with carcinogens. Evi-

dence is presented that each culture behaves as liquid tissue of an individual with physiological as well as morphological differentiation of cells, with the probable secretion of a hormone by relatively few cells which stimulates cell division. Carcinogens stimulate the division of senescent or injured cells which are not ordinarily susceptible to the action of the postulated hormone.

Stock cultures have long cycles of physiological activity which can be modified only slightly by frequent transfer to fresh media.

Attempted separation of morphological types of cells by fractional centrifugation and the selective action of media have been only partially successful, and it has been impossible to correlate these types with physiological activity.

Movements of translation similar to those of the Myxophyceae have been noted; also the presence of a gelified sheath which holds the cells together in small colonies.

Literature

No attempt has been made to review the extensive literature on carcinogens and their action, nor on factors influencing growth of yeasts. The following references include only those mentioned in the foregoing text.

Allsopp, C. B. ('40). Photo-oxides of carcinogenic compounds. Nature **145**: 303. *1 fig.*

Dodge, C. W. ('35). Medical mycology, fungous diseases of man and other mammals. St. Louis.

Dodge, C. W. and B. S. Dodge ('37). Some effects of methyl cholanthrene on the morphology and growth of yeasts. Ann. Mo. Bot. Gard. **24**: 583–590. *pl. 34.*

Fishbein, M., R. H. Weaver and M. Scherago ('40). The effect of 1:2:5:6: dibenzanthracene on the growth of *Escherichia coli.* [preprinted from Jour. Bact. **41**: 27–28. 1941]

Hopper, S. H. and D. B. Clapp ('39). Effect of carcinogenic and other hydrocarbons on the growth of *Escherichia communior.* Jour. Bact. **38**: 13–22. *1 fig.*

Loofbourow, J. R. and C. M. Dwyer ('38). Relative consistency of weights and counts in determining microorganisms by photoelectric nephelometers. Studies Inst. Div. Thomae **2**: 129–135. *3 fig.*

Nielsen, N. ('37). Untersuchungen über die Senkungsgeschwindigkeit der Hefe. C.R. Trav. Lab. Carlsberg, Ser. Physiol. **22**: 61–87.

Píšová, M. ('34). Anatomická struktura kvasinkových kolonií. Rozpravy II. Třídy Ceské Akad. **44**:41: 1–15. *1 pl.*

Richards, O. W. ('32). The second cycle and subsequent growth of a population of yeast. Arch. f. Protistenk. **78**: 263–301.

————, ('40). Yeast growth: a possible test organism for X-radiation. Radiology **38**: 317–326.

Satava, J. ('18). O redukovaných formách kvasinek. 50 p. *3 pl.* Praha.

Steinhaus, E. A. and J. M. Birkeland ('39). Studies on the life and death of bacteria. I. The senescent phase in aging cultures and the probable mechanisms involved. Jour. Bact. **38**: 249–261.

A MONOGRAPH OF THE GENUS PARMELIA IN NORTH AMERICA, NORTH OF MEXICO[1]

EDWARD CAIN BERRY

Formerly Graduate Student in the Shaw School of Botany of Washington University

Introduction

This study has been conducted with the purpose of bringing about an orderly arrangement of the species of *Parmelia* and to clarify the literature of the genus for North America, north of Mexico. During this investigation, all obtainable types were studied. Where types have been lacking, original descriptions and illustrations have been studied and compared with exsiccatae and collections from the type localities for the purpose of correlating the description of those species with the material at hand. To prevent confusion, in the literature of the genus Zahlbruckner's arrangement of the species in Engler and Prantl (Nat. Pflanzenfam. ed. 2, **8**: 233. 1926) has been followed, except where the monographer believes that Zahlbruckner is in error.

History

The genus *Parmelia* was established by Acharius in 1803, to supersede *Imbricaria* Acharius (1794). *Imbricaria* was used by various workers to designate the genus until 1930, when *Parmelia* Acharius was placed provisionally in *nomina generica conservanda,* and *Imbricaria* Acharius in *nomina rijicienda* (International Rules of Botanical Nomenclature, suppl. *nomina generica conservanda proposita.* 127. 1930). In Acharius' treatments subsequent to 1803 (Lichenographia Universalis. 1810; and Synopsis Methodica Lichenum. 1814), he removed considerable portions of the genus as first considered. Of the species which he retained in this last treatment, most remain in the genus as it is understood to-day.

[1] An investigation carried out at the Missouri Botanical Garden in the Graduate Laboratory of the Henry Shaw School of Botany of Washington University and submitted as a thesis in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Issued February 26, 1941. (31)

Dodge and Baker also agree that the type should be selected from this group (Second Byrd Antarctic Expedition—Botany. Lichens and Lichen Parasites. Ann. Mo. Bot. Gard. **25**: 589. 1938). This would conform with the present rules of Botanical Nomenclature since it would exclude the doubtful species and those which other workers have placed in related genera. The author feels that *Lichen saxatilis* Linn. meets all the requirements recommended for the selection of the type, it being a species with which Acharius was thoroughly familiar and at the same time one species which was universally recognized by early writers as a member of the genus *Parmelia*. Consequently, in this monograph, the type of the genus *Parmelia* is designated as *Parmelia saxatilis* (L.) Ach., Meth. Lich. 204–205. 1803. The description of the plant is given on page 82.

ECOLOGY

The area considered in this monograph includes continental North America, the immediately adjoining islands north of the international boundary of Mexico, and the islands of the Gulf of Mexico. This area represents a variety of habitats. The elevation varies from sea level to 4419.5 m.; the rainfall from less than 12.5 cm. to more than 508 cm. annually; the average annual temperature from 24° to 25° C., the temperature range from –45° to more than 56° C.

The lichens growing on the peaks of the higher mountains may be considered as occupying an arctic environment, the plants from the southern end of Florida and the mouth of the Mississippi as tropical in their affinities and climatic conditions. All of the species of *Parmelia* found in the area defined will be considered in this monograph regardless of their affinities or environmental conditions.

Species of *Parmelia* are found on rocks, bark of trees, fenceposts, buildings, fallen branches, logs, and rarely on the ground. Lichen growth is influenced by the environmental factors of water supply, substratum, wind, smoke, and temperature. Some species are tolerant to many environmental conditions and have a wide distribution; others, which have a very

limited tolerance to one or more of the environmental factors, are consequently more restricted.

Parmelia conspersa, P. caperata, P. centrifuga and *P. lineola* require full sunlight, growing on rocks, the upper branches of trees, and on buildings. These species are never seen in vigorous condition in shade or in subdued light. *Parmelia lineola* is found in the West and Southwest, covering the tops of rocks where they are exposed to the intense light of the desert sun.

Parmelia olivacea and its variety *aspidota* grow in shaded situations, the full light of the sun inhibiting their growth.

Another group which requires some direct sunlight but is seldom found in full light consists of *Parmelia rudecta, P. Borreri, P. cubensis,* and *P. erecta.* These lichens are found growing in positions where the full light of the sun falls on them for only a portion of the day.

The moisture requirement of the different species is very variable. *Parmelia lophyrea* is endemic only in the region of the Northwest where the moist wind of the Pacific Ocean comes in contact with the foothills of the mountains, while *P. lineola* is found in the desert section of the continent. *Parmelia enteromorpha* prefers a cool moist habitat, but also shows tolerance for desert conditions. The species attains its greatest size and abundance in the redwood section of northern California, but is also found in reduced size and numbers in the deserts of southern California.

The distribution of a number of species indicates a definite temperature limitation. *Parmelia Cladonia* is limited to the northeastern portion of the United States and the higher elevations of the Appalachian Highlands. It is common in the White Mountains of New Hampshire and continues south in the mountains at high elevation. The southernmost collection is from Clingmans Dome, Tennessee-North Carolina, an elevation of 6600 feet. *Parmelia physodes* is a common lichen in the timbered section of Canada, northern United States, and in the higher mountains to the south. In the lowlands, it extends south to Florida and Texas, gradually decreasing both in the number of individuals and in size. *Parmelia latissima,*

P. tinctoria and *P. livida* are abundant in Central America and Cuba. They grow also in the southern part of the United States, but never in localities where severe freezing occurs. *Parmelia caperata* and *P. Borreri* are found in all parts of the area studied, with little change in appearance. Smoke is always harmful to the species of *Parmelia,* and in any considerable concentration will destroy the plants entirely.[2]

MORPHOLOGY

Parmelia is leaf-like in form, growing above the surface of the substratum. It is composed of an upper cortex, an algal layer, medulla, and lower cortex. The cortex, sometimes referred to as a plectenchyma, is formed of small septate vertical hyphae which are woven into a firm layer. The distance between the septae is about equal to the diameter of the hyphae, giving the cortex the appearance of being formed of small isodiametric cells. The hyphae are separated by secretions which form a matrix characteristic of the species.

Cortex.—The thickness of the cortex in a species is characteristic, but it may be modified by age or environment. Old plants of some species in exposed situations may lose the entire upper cortex, in which case the whole upper surface becomes sorediose. In the younger portions of the thallus, the upper and lower cortex are essentially the same in thickness. Either the upper or lower cortex is often broken by cracks which permit the exchange of gases with the gonidial and medullary hyphae. In those species which have the margin of the thallus raised, as in *P. perforata* and *P. erecta,* the lower cortex is subject to the same factors of weathering as the upper cortex. The exposed portion of the lower cortex is approximately of the same thickness as that of the upper, while farther from the margin it is definitely thicker. The structure of the lower cortex is the same as that of the upper, except that from its surface either rhizinae or a cushion-like mass of hyphae arise. The outer layer of hyphal cells and the rhizoids are usually heavily

[2] Haugsjå, Pål K. Über den Einfluss der Stadt Olso auf die Flechtenvegetation der Bäume. Nyt Mag. Naturv. **68**: 1–118. 1930.

inflated with a dark brown or black pigment. A detailed study of the thickness of the thallus in 72 collections of *P. rudecta* shows that it varies from 400 to 810 μ, with an average thickness of 638 μ. The thickness of the upper cortex varies from 18 to 23 μ, with an average of 20 μ. The lower cortex varies from 65 to 84 μ, with an average of 73 μ. The variation of the algal layer is from 42 to 45 μ, with an average of 44 μ. The thickness of the medullary layer varies from 262 to 667 μ, with an average of 502 μ.

Isidia are coralloid branchlets and granules on the upper surface of such species as *P. caperata, P. Borreri, P. crinita,* and they are constant characters. They are the result of a continued growth upward of the vertical hyphae of the cortex. Some of the algal cells from the gonidia are carried up with the growing hyphae, and a gonidial layer is formed in these structures. Such outgrowths increase the photosynthetic area of the plant and also furnish an important means of vegetative reproduction. They contain all of the essential vegetative parts of the lichen body, and are easily broken off. They can be carried by wind, gravity, or by water to new locations, where they may produce new thalli.

Soredia are constant structures on some species of *Parmelia,* but never found on others. They are uncovered masses of hyphae which contain algal cells, and they may take the form of small round dots, as in *P. rudecta,* or confluent globular masses along the margins of the thallus, as in *P. cristifera.* Soredia arise from the gonidial layer of the thallus and reach the surface by the breaking, cracking, or loss of the cortex. The medullary hyphae absorb large quantities of water, and the imbibitional swelling causes them to exert pressure on the cortex when the plant is thoroughly wet, particularly after having been dried. The pressure of the medulla pushes the gonidial layer into the break and a soredium is formed. When the weakened portions of the cortex assume definite lines, the soredia are formed in a distinct pattern of reticulate ridges, as is seen in *P. sulcata.* In those species with definite marginal soredia, as *P. physodes* and *P. cristifera,* the upper and lower cortex are weakly joined together and the soredia are formed

by cracks at this line. The number and size of the soredia are determined by the extent of the weakness of the cortex and the amount of the swelling of the medullary hyphae. When the cortex is broken and the algae are placed in a position to secure more carbon dioxide, the rate of photosynthesis increases. Thus the food supply to the gonidial hyphae becomes greater and more rapid growth is produced. The soredia, being unprotected, are easily detached from the thallus by wind or rain. They thus serve as an important method of vegetative reproduction for those species in which they occur.

Gonidia.—The gonidial layer consists of algal cells (species of *Protococcus)* enmeshed in a tangle of thin-walled hyaline hyphae. The algae may form a continuous layer with the hyphae, or the layer may be lobed or even broken in spherical masses of hyphal and algal cells. The hyphae usually partly surround the algal cells with disk-like appressoria, though in many instances it is possible to see haustoria penetrating the cell walls of the algae. The algae of the gonidial layer supply the elaborated food for the fungus of the lichen.

Medulla.—The medullary layer consists of a loosely woven web of septate hyphae running parallel to the surface of the thallus. The hyphae are thick-walled and usually hyaline or very brown or yellowish. In a few species, *P. pertusa, P. physodes* and *P. olivacea,* some medullary hyphae are extremely large and dark brown or black. The medulla serves the purpose of holding the thallus together and providing a means of moving the nutritive materials in the plant. In species where the inflation of the thallus occurs, there is a separation of the hyphae of the medulla. The medullary hyphae are usually heavily impregnated with the lichen acids, as is shown by the reactions given with potassium hydroxide and calcium hypochlorite. The color of the medulla when exposed by the removal of the cortex is white or yellow. The loosely interwoven hyphae of the medulla also serve to provide a passage for gases through the thallus of the plant.

Apothecium.—The apothecium of *Parmelia* consists of an open disk on the upper surface of the thallus. The margin con-

sists of two well-defined layers. The inner layer is a continuation of the hypothecium and is of the same origin, structure, and color. This covering is a continuation of the protective hyphae which formed around the ascocarp when it first began development below the upper cortex. The hypothecium never contains any algal cells. The algae in the gonidial layer below the hypothecium are continuous with those in the thallus, and are always present except in those species in which the apothecium is perforated. The perforations of the apothecium arise from the death of the algal cells. In turn the hyphal cells die from lack of food supply and drop out, leaving a hole in the apothecium and thallus below. The perforation of the apothecium may appear occasionally in any species, but in certain species this is constant enough to provide a secondary diagnostic character. The apothecium may be sessile, attached directly to the thallus by the under-side, or it may be short-stipitate, the short stalk raising the fructification slightly above the surface of the thallus.

The amphithecium or outer protective layer surrounding the apothecium is similar in general appearance to the thallus, and is thalloid in origin. The hyphae forming it are a direct continuation of those of the thallus, but the variation in thickness is much less than in the thallus. The gonidia are continuous with the thalloid gonidia. The disk of the ascocarp is located just above the sub-apothecial gonidial layer and consists of a sterile base (the hypothecium) which is composed of small, closely woven, hyaline or light brown, septate hyphae. Immediately above the hypothecium lies the thecium, composed of the ascogenous hyphae, and asci, with the ascospores and the sterile paraphyses imbedded in a gell.

The asci are clavate, and usually contain eight ellipsoid ascospores. In a few species the number of spores may be two or four, as in *P. pertusa,* or many, as in *P. multispora.* The ascospores are hyaline, non-septate, and usually thin-walled. Occasionally the walls are thick, as in *P. Herreana.*

The paraphyses are septate, sparingly branched, and usually enlarged at the tip. The color of the disk is due to the color of the tips of the paraphyses and the surrounding gelatinous

matrix. In its development the epithecium, or disk covering, is not distinguishable from the open disk. The ascospores mature continuously throughout the existence of the open apothecium. It is common to find both young asci and mature spores in the apothecium of any species.

Spermagonium.—The spermagonia appear as black dots on the surface of the thallus or the apothecial margin. The black dot is the spermagonial opening, commonly called the ostiole. The spermagonium is a pyriform or spherical cavity with a black upper wall and a hyaline lower wall. Spermatophores arise from the hyaline portion of the wall and are sparingly branched. The spermatia are simple, straight, or cylindrical with a slight constriction in the middle. They are discharged through the ostiole along with a colorless gelatinous secretion when the thallus is wet. In *Parmelia* they are small and lack sufficient differentiation to be of taxonomic value in the genus.

Rhizinae.—The rhizinae arise on the lower surface of the thallus as outgrowths of the hyphae of the lower cortex. They may be lighter, darker, or of the same color as the surface of the lower cortex. They usually consist of numerous thread-like strands, but they may be either papillose or united into compact strands terminating in a mucilaginous disk called a haptorium. The rhizinae serve to attach the lichen to the substratum. There is little reason to believe that they have any considerable importance as organs of absorption or conduction of minerals in solution.

CHEMICAL REACTIONS

The color reactions of potassium hydroxide, calcium hypochlorite, and paraphenylendiamin are the result of these reagents on the specific lichen acids. A characteristic color reaction is an indication of the species of a lichen when taken in connection with morphological characters and distribution. A chemical reaction alone is not sufficient to differentiate a species. The technique followed in determining the color reaction was to make several "free hand" sections 40–100 μ in thickness through the thallus so that both cortices of the lichen

were shown. The sections were placed on a slide and the reaction of the chemical reagent on each part of the thallus was observed through a dissection microscope.

CHART OF CHEMICAL REACTIONS

Species	KOH	$CaOCl_2$	KOH+$CaOCl_2$	Paraphenyl-endiamin
olivacea var. *aspidota*	none	none	none	yellow
Bolliana	none	none	light pink	none
cetrata	none	none	none	none
cetrata var. *subisidiosa*	none	none	none	none
cirrhata	none	none	none	yellow
sphaerosporella	none	none	none	red-brown
chlorochroa	none	none	brown	yellow
cubensis	none	none	none	yellow
encausta	none	none	none	none
exasperata	none	none	none	none
caperata var. *incorrupta*	none	none	none	red
Hubrichtii	none	none	none	none
multispora	none	none	none	none
sulphurosa	none	none	none	none
olivacea	none	none	none	yellow
texana	none	none	brown	none
caperata var. *subglauca*	none	none	none	none
conspersa	yellow	none	none	red-brown
furfuracea	yellow	none	yellow	yellow
tinctoria	yellow	none	none	none
conspersa var. *isidiata*	yellow	none	none	none
caperata	yellow	none	none	red
centrifuga	yellow	none	yellow	none
crinita	yellow	none	none	none
conspurcata	yellow	none	red	none
endoxantha	yellow	none	yellow	yellow
enteromorpha	yellow	none	yellow	yellow
lophyrea	yellow	none	none	none
leucochlora	yellow	none	none	none
omphalodes	yellow	none	none	none
perforata	yellow	none	pink	none
perforata var. *hypotropa*	yellow	none	pink	none
pertusa	yellow	none	yellow	none
perlata	yellow	none	none	none
perlata var. *ciliata*	yellow	none	none	none
physodes	yellow—then red	none	brown	red
proboscidea	yellow	none	none	none
quercina	yellowish	none	none	yellow
sulcata	yellow	none	yellow	red-brown
lineola	yellow	none	none	none
saxatilis	yellow	yellow	yellow	red-brown
saxatilis var. *Anzi*	yellow	yellow	yellow	red-brown
cetrarioides	yellow	yellow	yellow	red-brown

CHART OF CHEMICAL REACTIONS (Continued)

Species	KOH	$CaOCl_2$	KOH+$CaOCl_2$	Paraphenyl-endiamin
erecta	none	yellow	yellow	yellow
livida	none	brown	brown	orange
Herrei	none	brown	none	none
Cladonia	brown	none	brown	yellow
praesignis	brown	none	none	gray
incurva	brown	none	none	none
aurulenta	brown	none	brown	brown
stygia	none	none	none	none
laevigata	brown	none	none	orange
prolixa	brown	none	none	none
sublaevigata	brown	none	none	none
pubescens	brown	none	none	none
caroliniana	brown	yellow	brown	none
cristifera	red	none	brown	red-brown
reticulata	red	none	none	none
Herreana	red	none	red	none
cetrarioides var. *rubescens*	red-brown	none	none	none
Finkii	none	red	red	none
rudecta	none	red	yellow	gray
soredica	none	red	none	none
olivacea var. *glabra*	none	red	none	none
Borreri	none	red	none	none
latissima	red	red	none	brick-red

ABBREVIATIONS

The herbaria from which material has been studied and from which specimens are cited in this monograph are indicated by the following abbreviations:

BSNH—Boston Society of Natural History, Boston, Mass.
BPI—Bureau of Plant Industry, Washington, D. C.
D—Private Lichen Herbarium of Dr. C. W. Dodge, St. Louis, Mo.
F—Farlow Herbarium, Cambridge, Mass.
FM—Field Museum of Natural History, Chicago, Ill.
IA—University of Iowa, Iowa City, Ia.
M—University of Michigan, Ann Arbor, Mich.
MIN—University of Minnesota, St. Paul, Minn.
MBG—Missouri Botanical Garden, St. Louis, Mo.

MONT—University of Montana, Missoula, Mont.
NYBG—New York Botanical Garden, New York, N. Y.
LSU—Stanford University, Palo Alto, Calif.
O—University of Ohio, Columbus, Ohio.
R—Russell Herbarium of Buffalo Society of Natural History, Buffalo, N. Y.
T—Tuckerman Herbarium, Harvard University, Cambridge, Mass.
US—United States National Herbarium, Washington, D. C.
W—Wellesley College, Wellesley, Mass.
WIS—University of Wisconsin, Madison, Wis.

Taxonomy

Parmelia Acharius, Meth. Lich. 153. 1803; Lichenogr. Univ. 89, 456. 1810; Syn. Meth. Lich. 195. 1814; Rabenh., Prodr. Fl. Neomarch. 299. 1804; Röhl., Deut. Fl. **3**, Abt. 2: 18. 1813; Mart., Fl. Crypt. Erlangens, 205. 1817; S. Gray, Nat. Arr. Brit. Pl. **1**: 436. 1821; Hook., Fl. Scot. **2**: 52. 1821; Fée, Essai Crypt. Ecor. Officin. 121, *pl. 62.* 1824; Fries, Syst. Orb. Veget. pars 1: 241. 1825; Lichenogr. Eur. Reform. 56. 1831; Duby, Bot. Gallic. **2**: 600. 1830; Eaton, Man. Bot. N. Amer. ed. 6, 56. 1833; Wallr., Fl. Crypt. German. **3**: 442. 1831; Taylor apud Mack., Fl. Hibern. **2**: 141. 1836; Rabenh., Deutschl. Krypt. Fl. Rar. **2**: 54. 1845; Tuck., Enum. N. Amer. Lich. 49. 1845; De Not., Mem. Accad. Sci. Torino, II. **10**: 378. 1849; Schaer., Enum. Crit. Lich. Europ. 33. 1850; Nyl., Mem. Soc. Nat. Cherbourg **3**: 174. 1855; Syn. Lich. **1**: 375. 1860; Mudd, Man. Brit. Lich. 92. 1861; Müller-Argau, Mem. Soc. Phys. & d'Hist. Nat. Genève **16**: 372. 1862; Kickx, Fl. Crypt. Flanders **1**: 218. 1867; Th. Fries, Lichenogr. Scand. **1**: 111. 1871; Leighton, Lich. Fl. Gt. Brit. 122. 1871; Sydow, Flecht. Deutschl. 32. 1887; Wainio, Étude Lich. Brésil **1**: 27. 1890; Crombie, Monogr. Lich. Brit. **1**: 232. 1894; Calkins, Lich. Fl. Chicago & Vic. 18. 1896; Oliver, Expos. Lich. Ouest Fr. **1**: 107. 1897; Schneid., Textbook Gen. Lichenol. 167. 1897; Zahlbr. apud Engl. & Prantl, Nat. Pflanzenfam. 1 Teil, Abt. 1: 211. 1907, and ed. 2, **8**: 233. 1926; Fink, Contrib. U. S. Nat. Herb. **14**: 190. 1910; Lich. Fl. U. S. 320. 1935; Herre, Proc. Wash. Acad. Sci. **12**: 193. 1910; A. L. Smith, Monogr. Brit. Lich. **1**: 118. 1918; Handbook Brit. Lich. 35. 1921; Dodge & Baker, Ann. Mo. Bot. Gard. **25**: 589. 1938.

Imbricaria Acharius, Kgl. Svenska Vetensk. Akad. Nya Handl. **15**: 250. 1794; Michaux, Fl. Bor.-Amer. 322. 1803; DC. apud Lam. & DC., Fl. Fr. ed. 3, **2**: 385. 1815; Kickx, Fl. Crypt. Louvain, 72. 1835; Körb, Lich. Germ. Spec. 8. 1846; Krmphbr., Geschichte d. Lich. **2**: 49. 1869; Arnold, Lich.-Fl. München. Ber. Bayr. Bot. Gesells. **1**: 26. 1891.

Parmelia sect. *Lobaria* Sprengel, Fl. Halensis, 332. 1806.

Physcia S. Gray, Nat. Arr. Brit. Pl. **1**: 455. 1821.

Parmelia sect. *Imbricaria* Fries, Syst. Orb. Veget. pars 1: 242. 1825; Tuck., Enum. N. Amer. Lich. 49. 1845; Schaer., Flora **32**: 291, 296. 1849.

Parmelia Lobaria sect. *Imbricaria* Endlicher, Gen. Pl. 15. 1836.

Parmelia sect. *Parmelia* Hooker, Handbook New Zealand Fl. 571. 1867.

Parmelia subgen. *Euparmelia* Harmand, Bull. Soc. Sci. Nancy, II. **31**: 216. [1896] 1897.

The type of the genus is *Parmelia saxatilis* (L.) Ach., Meth. Lich. 204–205. 1803.

Thallus foliose, appressed or ascending, laciniate, with rounded, linear, or filiform lobes, often imbricate; upper surface often sorediose or isidiose, lower surface either lighter or darker than the upper, usually covered with rhizoids except at the margins; upper and lower cortex of vertical hyphae woven into plectenchyma; rhizinae arising from a fusion of hyphae of the lower cortex; medulla of loosely woven periclinal hyphae; algae *Protococcus;* apothecium on upper surface never marginal, sessile or short-pedicellate, disk concave or flat, chestnut-brown, amphithecium prominent, hypothecium hyaline with algae below; paraphyses imbedded in a gell, usually branched and septate, clavate or pointed at the tips; asci clavate, usually 8-spored, ascospores hyaline and unicellular, ellipsoid or spherical; spermagonia immersed in surface of thallus or amphithecium, spherical or pyriform, opening by black ostioles, wall black or dark brown above, light brown or hyaline below, spermatophores simple or branched, spermatia oblong with acute tips or sometimes fusiform.

KEY TO THE SUBGENERA OF PARMELIA

A. Always with thick rough lower cortex; rhizinae never present.
  B. Thallus with oval perforations; spores 2–4, large.....*Menegazzia*
  B. Thallus never with oval perforations; spores 8, small.....*Hypogymnia*
A. Never with thick rough lower cortex; rhizinae always present.
  B. Thallus foliose, lobes never channeled.....*Euparmelia*
  B. Thallus always fruticose, lobes channeled.....*Pseudevernia*

MENEGAZZIA

I. **Parmelia** subgenus **Menegazzia** Wainio, Étude Lich. Bresil **1**: 27. 1890.

Menegazzia Mass., Neag. Lich. 3. 1854.

The type used for the subgenus by Wainio is *Parmelia pertusa.*

Thallus always without rhizinae, attached by mucilaginous secretions; lower part of medulla composed of large dark brown or black hyphae, upper part, of small hyaline hyphae; upper cortex always perforate; ascus clavate, spores 2–4, large, hyaline.

The small number of large spores and distinctive medullary hyphae make this subgenus very different from the remainder of the *Parmeliae.* It is probable that the *Menegazziae* are not closely related to the remainder of the genus. The *Menegazziae* are represented in North America by one species, *Parmelia pertusa* (Haller) Schaer., whose distribution is in the northern or mountainous areas.

1. Parmelia pertusa (Haller) Schaer., Lich. Helvet. Spic., sect. 10:457. 1840.

Lichen pertusus Haller, Hist. Pl. Helvet. 2012. 1769; Schrank. Baier. Fl. **2**: 519. 1789.

Lobaria terebrata Hoffm., Deutschl. Fl. **2**: 151. 1795.

Lichen diatrypus Ach., Lichenogr. Suec. Prodr. 116. 1798.

Imbricaria diatrypa DC. apud Lam. & DC., Fl. Fr. ed. 3, **2**: 393. 1815.

Schaerer's type is 'Lichenes Helvetici Exsiccati,' 365, in Herbier Boissier, Université de Genève, Switzerland, the type collection having been made in the Swiss Alps. Schaerer referred to Schrank's *Lichen pertusus* (Baierische Flora **2**: 519.

1789) but Schrank used as his type the description of *Lichen pertusus* Haller (Historia Plantarum Helvetiae, 2012. 1769). Hoffmann cites Schrank's *Lichen pertusus* as synonymous with his plant. Acharius considered *Lichen diatrypus* (Lichenographiae Suecicae Prodromus, 116. 1798) the same as Schrank's *Lichen pertusus*. DeCandolle cites *Lichen diatrypus* Ach. as synonymous with his *Imbricaria diatrypa*.

Thallus glossy, ash-gray to greenish-brown above, closely adnate, sparingly perforated with round to oblong holes, inflated, lobes crowded, imbricated, with scattered confluent round white soredia on the rounded margins; upper and lower cortex easily separated, often pulling away and leaving the white medulla exposed, black below, brown at the margins, wrinkled; apothecia rare, 2–9 mm. diameter, sessile, disks concave, chestnut-brown; K, yellow, C, none, K + C, yellow, P, none.

Algal layer continuous, 25 μ thick; upper cortex 12.76–14 μ thick, lower cortex 15–20 μ thick; medullary hyphae 1 μ diameter, a web of heavy dark brown hyphae 3.19 μ in diameter extending from the lower part of the medulla often through cracks in the lower cortex, the line of cleavage in the inflation of the thallus being at the junction of the small hyaline hyphae and the heavy dark hyphae; thallus 600–650 μ thick; thecium 70–90 μ thick; asci clavate, spores 2–4, hyaline, ellipsoid, 20–30 × 50–60 μ; spermatia straight, cylindrical, spermagonia subspherical, ostioles not raised on the surface of the thallus.

Distribution: Nova Scotia to Maryland, west to British Columbia, south to Washington.

NOVA SCOTIA: on tree trunks, Bridgewater, Aug. 10, 1910, *Macoun 237* (MBG); on spruces, near Digby, May 20, 1910, *Macoun* (F); *Rothrock* (FM).

NEW BRUNSWICK: on trunks, Yarmouth, June 6, 1910, *Macoun* (MBG).

QUEBEC: on trees, Montmorency Falls, June 24, 1905, *Macoun 13* (F).

MAINE: KNOX CO.: on trunks of spruces, Mount Battie, Camden, May 1, 1910, *Merrill* (F).

NEW HAMPSHIRE: GRAFTON CO.: Franconia Notch, Oct. 14, 1884, *Faxon* (F). COOS CO.: on rocks, White Mountains, *Calkins* (FM); White Mountains, *Willey* (MIN).

VERMONT: ADDISON CO.:on cedar tree, Scandon Swamp, Leicester, May 22, 1920, *Dutton 1012* (MBG,FM,WIS). ORLEANS CO.: outlet Willoughby Lake, June 26, 1884, *Faxon* (WIS).

MASSACHUSETTS: BRISTOL CO.: trunks and rocks, New Bedford, *Willey 59* (FM,MBG,R).

NEW YORK: HAMILTON CO.: Indian Lake, *Peck 10* (R). WASHINGTON CO.: on bark, Archdale, Nov. 1871, *Clinton* (R).

PENNSYLVANIA: LANCASTER CO.: on trunks, Bear Town, *Eby* (MBG).

MARYLAND: ANN ARUNDEL CO.: on holly at Boiling Spring, Dec. 12, 1905, *Plitt* (BPI).

WEST VIRGINIA: POCAHONTAS CO.: Brown's Creek Road, Huntersville, Feb. 6, 1930, *Gray L1380* (NYBG).

MINNESOTA: COOK CO.: on cedars in swamp, Grand Marais, Jan. 29, 1902, *Fink 5240* (MIN).

BRITISH COLUMBIA: on limbs of trees, Vancouver Island, May 5, 1909, *Macoun 14.09* (F).

WASHINGTON: Washington Territory, *Davis* (BSNH). CHEHALIS CO.: on trunks of trees, Aberdeen, Apr. 1909, *Foster 35* (F,MIN); on trees, Montesano, June 1919, *Grant 3030* (F). KING CO.: on *Cascara*, Wynaco, 1918, *Grant* (FM).

FOREIGN AND LOCAL EXSICCATAE: Claud. *19;* Cromb. *145;* Erb. I, *832;* Flag. Lich. Fr.-C. *17;* Hav. Occid. *18;* Larb. Caes. *66;* Malbr. *225;* Malme, *176;* Merrill, *35;* Nyl. Par. *32;* Picq. *74;* Rab. Cent. *7;* Schaer. *365;* Trev. *156;* Zw. *252.*

KEY TO SPECIES IN SUBGENUS HYPOGYMNIA

A. Lobes always inflated.
  B. Medullary hyphae all of one type; spores spherical, 3 × 3 or 4 × 4 μ.... .....4. *lophyrea*
  B. Medullary hyphae of two types.
    C. Usually sorediate; spores 4–6 × 6–8 μ; K, yellow, then red, C, none .....2. *physodes*
    C. Rarely sorediate; spores 4–6 × 7–10 μ; K, greenish-yellow, C, none.... .....3. *enteromorpha*
A. Lobes never inflated; K, none, C, none.....5. *encausta*

HYPOGYMNIA

II. **Parmelia** subgenus **Hypogymnia** Nyl., Flora **64**: 537. 1881.

Nylander's type for this subgenus is *Lichen physodes* L.

Thallus gray, yellowish-brown, or black; under-side black, roughened and without rhizinae; medulla often with a cavity; marginal or terminal soredia common except in *Parmelia enteromorpha.* The distribution of the subgenus is world-wide in the colder or mountainous regions.

2. Parmelia physodes (L.) Ach., Meth. Lich. 250. 1803.

Lichen physodes Linn., Sp. Pl. 1144. 1753.

Lichen laciniatus var. *physodes* Weis, Pl. Crypt. Fl. Goetting. 57. 1770.

Lobaria physodes Hoffm., Deutschl. Fl. **2**: 150. 1795.

Imbricaria physodes DC. apud Lam. et DC., Fl. Fr. ed. 3, **2**: 393. 1815.

Parmelia physodes var. *vulgaris* Th. Fries, Lichenogr. Scand. **1**: 117. 1871.

Menegazzia physodes Navas, Lich. de Aragon, 25, 1908.

The type of the species used by Acharius is based on a collection in the Herbarium of Linnaeus. He cites as synonymous Jacquin 'Collectanea ad Botanicam' **3**: *t. 8, f. 2 & 3.* 1789, Hoffmann, 'Enumeratio Lichenum,' *t. 15, f. 2a & b.* 1784, and Dillenius, 'Historia Muscorum,' *t. 20, f. 49.* 1741. The collection of the type species was from trees or rocks in northern Europe. The type of F. W. Weis, given in 'Plantae Cryptogamicae Florae Goettingensis,' 57. 1770 is based on *t. 20, f. 49* in Dillenius, 'Historia Muscorum,' Acharius, 'Lichenum Suecicae Prodromus,' 115. 1798, and Wulfen apud Jacquin 'Collectanea' **3**: *t. 8, f. 2 & 3.* Wallroth considered his *Parmelia ceratophylla* var. *phyllodes* the same as Dillenius' plant.

Thallus middle-sized to large, irregular in outline, 5–15 cm. diameter, loosely adnate, lobes inflated, long, narrow, dichotomously branched, imbricated, usually with marginal soredia, often with slightly raised tips; upper surface smooth, greenish-gray to whitish, margins often brownish or black, lower surface black, without rhizinae, roughened and much wrinkled; cortex continuous except at junction of lower and upper cortex, where it is often broken exposing the white medulla; apothecium sessile or short-pedicellate, 2–15 mm. diameter, disk concave, chestnut-brown, margin of the amphithecium entire, smooth; K, yellow, then red, C, none, K + C, brown, P, red.

Algal layer continuous or cells grouped, 10–15 μ thick; upper cortex 12–18 μ thick, cells of the vertical hyphae small and hyaline but separated by a dark brown matrix, giving the appearance of a brown net; medulla of loosely interwoven hyphae of two types, (1) those on the upper side hyaline and of small diameter, (2) those on the lower side dark brown and of large diameter, the inflation of the thallus occurring at the junction of the two types; lower cortex 12–20 μ thick, matrix dark brown

or black; thickness of the thallus extremely variable, 30–200 μ; thecium 30–36 μ thick; ascus clavate or almost spherical, spores 8, 4–6 × 6–8 μ; paraphyses branching once or twice, tips slightly enlarged.

Distribution: Labrador to northern Alabama, west to British Columbia, south to California.

LABRADOR: on earth, Forteau, Sept. 19, 1889, *Waghorne 69* (MIN); on branches of spruce, Aug. 23, 1896, *Low* (F).

NEWFOUNDLAND: on trees, Coria Cove, Bay of Tiland, Sept. 15, 1856, *Waghorne* (MBG); on rocks, Hodges Cove, Trinity Bay, June 29, 1885, *Waghorne 10* (MBG); Chance Cove, Trinity Bay, May 24, 1893, *Waghorne* (MBG); Chance Cove, Trinity Bay, May 26, 1893, *Waghorne* (MIN); on trees, "Bay of Bull Coeur," May 28, 1893, *Waghorne* (MIN); on trees, New Haven, June 21, 1893, *Waghorne 32* (MIN); on gravelly sand, July 27, 1893, *Waghorne* (MIN); on trees, New Harbor, Sept. 21, 1893, *Waghorne 69* (MIN); on rocks, Hodges Cove, Random, Mar. 22, 1895, *Waghorne* (MBG); on trees, Cold Cove, Bay of Hand, Sept. 15, 1896, *Waghorne 69* (MIN).

NOVA SCOTIA: *Rothrock* (FM).

NEW BRUNSWICK: Little Branch, Miramichi, June 15, 1897, *Fowler* (F).

QUEBEC: alluvial woods along Riviere Cap Chat, July 6, 1923, *Collins & Dodge* (D); on rocks covered by mould, Ste. Anne, May 11, 1935, *Lepage 143* (D); on rotten logs, Ste. Anne, May 30, 1935, *Lepage 480* (D); dry peaty knowls and slopes by Lac Pierre, elev. about 1100 m., Table Top Mountain, Aug. 6, 1923, *Fernald, Dodge & Smith* (D).

ONTARIO: on rocks and trees, Ottawa, Apr. 26, 1891, *Macoun* (MBG); on trunks, Ottawa, May 16, 1903, *Macoun 242* (MBG); on rocks and trees, Ottawa, Apr. 26, 1891, *Macoun 77* (MIN,WIS); on fences and tree trunks, Apr. 24, 1892, *Macoun* (MBG); Rainy Lake, Aug. 20, 1930, *Schmidt* (MBG); on trees, Emo, July 18, 1901, *Fink 719* (MIN).

MAINE: WASHINGTON CO.: June 1929, *Markin* (WIS). HANCOCK CO.: Winter Harbor, Apr. 30, 1923, *Norton* (F); Mount Desert, July 1928, *Markin* (WIS). KNOX CO.: on rocks, Mount Battie, *Merrill* (F).

NEW HAMPSHIRE: CARROLL CO.: Chocorua, Aug.-Sept. 1911, *Farlow 479b* (F,WIS). GRAFTON CO.: on coniferous trees, Plymouth, Mar. 31, 1891, *Cummings 9b* (WIS,MBG); on coniferous trees, North Woodstock, Franconia Mountains, July 27, 1891, *Cummings 9a* (WIS,MBG). SULLIVAN CO.: spruce and hemlock woods, elev. 1460 ft., Lempster, Aug. 1927, *Butler* (FM).

VERMONT: WINDHAM CO.: Grout Pond, Stratton, July 4, 1925, *Moore* (MBG). ADDISON CO.: Middlebury, Apr. 1913, *Dodge 152* (D); on roots of *Pinus Strobus*, Middlebury, May 7, 1913, *Dodge* (D); Green Mountain Chain beyond Breadloaf, Ripton Hancock Road, July 29, 1916, *Dodge* (D); on cedar trees, Leicester Brook Swamp, elev. 350 ft., Feb. 2, 1920, *Dutton 966* (F); Bristol Bog, June 24, 1927, *Dodge* (D); Starksboro Bog, June 25, 1927, *Dodge* (D); Monkston, June 25, 1927, *Dodge* (D). RUTLAND CO.: Brandon, March 12, 1911, *Dutton* (MBG); on cedar trees in swamp, Brandon, Feb. 26, 1921, *Dutton 1216* (WIS,FM); Chipman Lake, Tinmouth, June 1938, *Dodge* (D).

MASSACHUSETTS: MIDDLESEX CO.: Pepperell Station, Oct. 1926, *Dodge* (D). BRISTOL CO.: trees and rocks, New Bedford, *Hall 38* (FM). WORCESTER CO.: 1885, *Sargent 424* (F).

CONNECTICUT: WINDHAM CO.: on tree, Pomfret, Oct. 29, 1925, *Evans 605* (F).

NEW YORK: ESSEX CO.: on mosses near Lake Placid, Sept. 1–16, 1898, *Britton* (F); on spruce, Lake Placid, Sept. 27, 1914, *Humphrey* (WIS); on balsam, Mount Marcy, near Lake Placid, elev. 5300 ft., Aug. 16, 1933, *Lowe 2830* (F). YATES CO.: Dundee, *S. Wright* (FM); on dead twigs of balsam firm, Dec. 31, 1894, *Galway* (F). Dundee, *S. Wright* (FM); on dead twigs of balsam fir, Dec. 31, 1894, *Galway* (F).

NORTH CAROLINA: WATAUGA CO.: on bark of trees, Grandfather Mountain, June 16, 1923, *Schallert* (F); SWAIN CO.: deep wet woods, Clingmans Dome, elev. 6600 ft., Aug. 25, 1937, *Hubricht B554* (MBG); woods, elev. 5500 ft., Newfound Gap, Aug. 25, 1937, *Hubricht* (MBG).

OHIO: MAHONING CO.: on old stump, Ellsworth, Apr. 1910, *Vickers 39* (BPI).

WEST VIRGINIA: POCAHONTAS CO.: on dead spruce, Bald Knob, July 19, *Gray* (F); MERCER CO.: on roof of shed near Coopers Rock, July 28, 1907, *Sheldon 1056* (F).

MICHIGAN: CHEBOYGAN CO.: Mud Lake Bog, vicinity of Burtt and Douglas lakes, June–Aug. 1923, *Nichols* (F). KEWEENAW CO.: on conifer, McCargo Cove, Isle Royale, Aug. 4, 1930, *Lowe 314* (F); Isle Royale, Sept. 10, 1901, *Stuntz & Allen* (WIS); on birch, Rock Harbor, Isle Royale, Aug. 1904, *Harper & Harper 173* (FM).

INDIANA: COUNTY UNKNOWN: on trees, 1827, *Engelmann* (MBG).

TENNESSEE: HAMILTON CO.: on oaks, Lookout Mountain, *Calkins 288* (FM); SEVIER CO.: deep wet woods, Clingmans Dome, elev. 6600 ft., Aug. 25, 1937, *Hubricht* (MBG); woods, elev. 5500 ft., Newfound Gap, Aug. 25, 1937, *Hubricht B554* (MBG).

WISCONSIN: VILAS CO.: valley of the Wisconsin River, near Lac Vieux Desert, June 13, 1893, *Cheney 67* (WIS); Lost Creek, near Sayner, Aug. 30, 1938, *J. Thomson* (WIS). TAYLOR CO.: valley of the Wisconsin River near Goodrich, summer 1894, *Cheney* (WIS). FOREST CO.: on soil east of Three Lakes, May 30, 1938, *Wolf 6* (WIS).

ILLINOIS: county unknown: *Calkins* (FM).

MINNESOTA: LAKE CO.: on trees, Snowbank Lake area, July 21, 1897, *Fink 863* (MIN). ST. LOUIS CO.: on cedar in swamps, Harding, Aug. 17, 1901, *Fink 1553* (MIN); on rocks, Tower, Aug. 24, 1901, *Fink 1720* (MIN). CARLTON CO.: on trees, Kettle Falls, Aug. 12, 1901, *Fink 1402* (MIN); on trees, Tafte, Carlton Peak, July 10, 1897, *Fink 565* (MIN). KOOCHICHING CO.: on trees and rocks, Gunflint, July 2, 1897, *Fink 383* (MIN); on trees, Koochiching, July 27, 1901, *Fink 965* (MIN); on rocks, Koochiching, July 31, 1901, *Fink 1050* (MIN); on rocks, Rainy Lake City, Aug. 1, 1901, *Fink 1099* (MIN); on trees, Rainy Lake City, Aug. 7, 1901, *Fink 1267* (MIN). BELTRAMI CO.: on tamarack in swamp, Red Lake, July 27, 1900, *Fink 913* (MIN); on pines, Bemidji, July 4, 1900, *Fink 429* (MIN); in swamps, Beaudette, June 18, 1901, *Fink 28* (MIN); on trees, Red Lake, Aug. 3, 1900, *Fink 1071* (MIN); on trees in swamps, Beaudette, June 18, 1901, *Fink 6* (MIN); on pine, Bemidji, July 12, 1900, *Fink 669* (MIN); on tamarack and red cedar in a tamarack swamp, Bemidji, July 9, 1900, *Fink 514* (MIN). CASS CO.: on trees and rocks, Grand Portage Island, June 23, 1897, *Fink 143* (MIN). OTTERTAIL CO.: on tamarack in

swamps, Henning, June 28, 1900, *Fink 331* (MIN). ROSEAU CO. on tamarack in swamp, Warroad, June 28, 1901, *Fink 246* (MIN).

SOUTH DAKOTA: COUNTY INDEFINITE: Black Hills, *Macbride* (IA).

MONTANA: CLARK CO.: on live *Salix*, S. 11. T. 12 N. R 9 W., Jefferson Creek, Helena, Aug. 15, 1931, *Flint* (MONT). MISSOULA CO.: north slope of Mitten Mountain, Dec. 13, 1932, *Flint, Jr.* (MONT). COUNTY INDEFINITE: Douglas fir bark, both dead and green trees, sect. 19. T. 12 N. R 6 W., elev., 5000 ft., May 28, 1931, *Flint* (MONT.)

NEW MEXICO: COLFAX CO.: on *Pseudotsuga mucronata*, vicinity of Ute Park, elev. 2200–2900 m., Aug. 21, 1916, *Standley* (F).

ALBERTA: Banff, woods, Oct. 1910, *Swanson 354* (F); Sulphur Mountain, Oct. 18, 1918, *Swanson S72* (F).

IDAHO: IDAHO CO.: by the highway near Locha River west of Lolo Pass, Sept. 15, 1937, *Barkley 1576* (MONT).

BRITISH COLUMBIA: Ucluelet, on old logs and rocks, May 11, 1909, *Macoun* (MBG); Lillocet, July 1916, *Macoun* (F); New Westminster, Jan. 1903, *Merrill* (F).

WASHINGTON: SPOKANE CO.: on bark of *Pinus ponderosa*, 5 miles southwest of Spokane, May 30, 1933, *Flint* (MONT). COLUMBIA CO.: on branches, Blue Mountains, Oct. 17, 1831, *Howard 1620a* (W). PIERCE CO.: on trees, Longmires Springs, Aug. 1906, *Harper & Harper 255* (FM); Sumner, June 1906, *Harper & Harper 254* (FM). ISLAND CO.: on log, Langley, *Grant* (FM); on trees, Langley, 1926, *Grant* (WIS); on trees, Langley, 1923, *Grant* (W); on rock, Langley, June 1923, *Grant* (W); Goose Rock, July 1923, *Grant* (W). SAN JUAN CO.: San Juan Island, July 1906, *Harper & Harper* (FM). CLALLAM CO.: on roof, Sequim, 1915, *Grant 213* (F). COUNTY UNKNOWN: on wood, *Calkins* (MBG).

CALIFORNIA: MARIN CO.: on trees, Mar. 29, 1893, *Howe 25* (MBG); COUNTY INDEFINITE: on limbs of Manzanita bush, Cuyamaca Mountains, elev. 4500 ft., 1932, *Cota* (MBG).

LOCAL AND FOREIGN EXSICCATAE EXAMINED: Cum. I *9a, b;* Tuck. II–IV *72; P. physodes austerodes* Norrl. & Nyl. *209a, b.*

This species is distributed in the cooler and mountainous regions of both hemispheres. It commonly grows on rocks, but may be found on tree trunks and more rarely on earth. In North America, collections have been made from Labrador to North Carolina on the east coast, and from Alaska to central California on the west coast. Collections in the interior of the country, except in the mountains, have not been made south of Illinois. Workers with North American lichens have often recognized *Parmelia physodes* var. *labrosa* Ach., *Parmelia physodes* var. *obscura* Ach., *Parmelia physodes* var. *platyphylla* Ach. and *Parmelia physodes* var. *vittata* Ach. as distinct. These forms seem to be valid for European material, but not for that from North America. The plants from North America

bearing these names are environmental variants rather than distinct varieties of the species *P. physodes* Ach.

3. Parmelia enteromorpha Ach., Meth. Lich. 252. 1803.
Lichen intestinalis Sm. apud Ach., Meth. Lich. 252. 1803.
Parmelia physodes var. *enteromorpha* Tuck., Proc. Amer. Acad. Arts & Sci. 1: 220. 1848.
Hypogymnia enteromorpha Nyl., Acta Soc. Sci. Fenn. **26**[10]: 7. 1900.
Imbricaria enteromorpha Jatta, Nuov. Giorn. Bot. Ital. N. S. **9**: 471. 1902.

Acharius' type was Menzies' collection from the west coast of North America, near Monterey, California. The type is now in Acharius' Herbarium in Helsinki, Finland. Acharius cites as a synonym of his species J. E. Smith's *Lichen intestinalis* from Menzies' type. Tuckerman used as the type of his variety *enteromorpha* a duplicate collection of Menzies' which is probably co-type material. The type of the variety is in Tuckerman's Herbarium in the Farlow, at Harvard University. Nylander's and Jatta's synonyms were based on Menzies' collection and arose from the renaming of the genus.

Thallus large, loosely attached; upper surface green, dingy gray or brownish, smooth, with numerous black dots which are the open ostioles of the spermagonium; lobes numerous, long, narrow, inflated or occasionally broad at the tip; lower surface black, rough; lower cortex often cracked or broken, exposing the white medulla; apothecium abundant, short-pedicellate, 5–8 mm. diameter, disk concave, flat or sometimes convex, occasionally perforate at the center, pedicel always hollow, amphithecium entire or lobed; K, yellow or greenish-yellow, C, none, K + C, yellow, P, yellow.

Algal layer continuous, 12–15 μ thick; upper cortex 9–19 μ thick; medulla loosely interwoven with a central cavity, hyphae of two types, (1) large, brown, 2–3 μ in diameter, and (2) hyaline, 1 μ or less in diameter, the large dark brown hyphae being on the lower side of the thallus and an inflation occurring at the junction of the two types; lower cortex 24–27 μ thick, matrix brown; thecium 21–25 μ thick; ascus clavate, spores 8, 4–6 × 7–10 μ; paraphyses branched.

Distribution: Labrador to Virginia, west to Alaska, south to California.

LABRADOR: on earth, Oct. 18, 1894, *Waghorne* (MIN).

NEWFOUNDLAND: on sand, July 27, 1893, *Waghorne* (MBG); on earth, Sept. 28, 1894, *Waghorne* (MBG); on earth, Bay Island, Aug. 22, 1896, *Waghorne* (MBG); sea cliff, Goose Arm, Bay of Hand, Sept. 22, 1896, *Waghorne* (MBG); on earth, Sept. 28, 1899, *Waghorne* (US).

MAINE: HANCOCK CO.: Beech Mountain, July 8, 1894, *Merrill 89* (WIS). KNOX CO.: on spruces, Camden, 1910, *Merrill 89* (WIS). YORK CO.: Saco, 1863, *Blake* (FM).

NEW HAMPSHIRE: COOS CO.: White Mountains, 1863, *Mann* (FM); base of Mount Washington, Aug. 6, 1895, *Harper & Harper 35* (FM). GRAFTON CO.: on coniferous trees, North Woodstock, Franconia Mountains, July 27, 1891, *Cummings* (MBG).

VERMONT: LAMOILLE CO.: on twigs, Mount Mansfield, Aug. 11, 1851, *Russell* (R).

VIRGINIA: WASHINGTON CO.: summit of White Top Mountain, elev. 5678 ft., May 28, 1892, *Small* (MIN).

NORTH CAROLINA: MITCHELL CO.: on trees, Roan Mountain, June 15, 1936, *Schallert* (B).

MONTANA: FLATHEAD CO.: 2½ miles up Glen Trail east from Flathead Lake, Nov. 18, 1934, *Flint* (MONT); Columbia Falls, Sept. 26, 1892, *Williams 2b* (MIN). MISSOULA CO.: dead twigs of conifer, north slope of Mitten Mountain, near Missoula, elev. 3500 ft., Dec. 1930, *Flint* (MONT); on dead twigs of Douglas fir, Kitchen Gulch near Clinton, Nov. 25, 1931, *Flint* (MONT); north slope of Mitten Mountain, elev. 3700 ft., near Missoula, *Flint* (MONT).

WYOMING: on dead twigs of *Pinus contorta*, Snake River drainage of Yellowstone Park, elev. 7000 ft., July 20, 1931, *Flint* (MONT).

IDAHO: NEZ PERCE CO.: above Lake Waha, elev. 2000–3500 ft., June 3, 1896, *Heller & Heller* (MBG). KOOTENAI CO.: on upper branches of *Pinus monticola*, head of Little Lost Fork, Big Creek, Coeur d'Alene, Aug. 30, 1931, *Flint* (MONT).

MACKENZIE TERRITORY: Arctic Ocean, Elephant Point, Eschscholtz Bay, Sept. 1880, *Bean* (FM).

YUKON: on trunks in woods, The Cone, 1902, *Macoun* (MBG).

ALASKA: on hemlocks, Windham Bay, elev. 1700 ft., Oct. 4, 1905, *Culbertson 126* (FM,F); Cooks Inlet, Fort Alexander, 1880, *Bean* (FM).

BRITISH COLUMBIA: Vancouver Island, Oregon Boundary Commission, 1858–59, *Lyall* (R,WIS); on trees and rotten logs, Victoria, Vancouver Island, May 1887, *Macoun 69* (MIN,WIS); on trees, Donald, July 6, 1885, *Macoun* (MBG); on old wharf of Comox, June 23, 1893, *Macoun* (US); on branches of trees and bushes, Victoria, Vancouver Island, July 23, 1887, *Macoun* (MBG); Surrey, *Hill* (F); near McLeod Lake, June 27, 1875, *Macoun* (F); northwest coast of North America, 1901–02, *Newcombe 148* (FM).

WASHINGTON: SNOHOMISH CO.: Snohomish, *Harper & Harper 277* (FM). PEND D'OREILLE CO.: Pend d'Oreille, Oregon Boundary Commission from Fort Colville to Rocky Mountains, 1861, *Lyall* (R). SPOKANE CO.: high up in old yellow pine, 6 miles south of Spokane, Apr. 29, 1934, *Flint* (MONT); bark of *Pinus ponderosa*, 5 miles southwest of Spokane, May 31, 1939, *Flint* (MONT). WHITMAN CO.: very abundant on lower dead branches of yellow pine, along Palouse River near Palouse,

Aug. 12, 1938, *Ownbey & Ownbey* (MBG). STEVENS CO.: on wood, Kettle Point, July 3, 1907, *Cowles 318a* (FM). PIERCE CO.: on trees, Longmires Springs, Aug. 1906, *Harper & Harper* (FM); Ashford, Aug. 1906, *Harper & Harper* (FM); Sumner, June 1906, *Harper & Harper* (FM). ISLAND CO.: on logs, Langley, 1922, *Grant* (WIS). SAN JUAN CO.: Rock Harbor, July 3, 1905, *Frye* (F); San Juan Island, July 1906, *Harper & Harper* (FM); on wood, Friday Harbor, July 2, 1907, *Cowles 318* (FM). CLALLAM CO.: on rocks, Port Angeles, Mar. 5, 1914, *Foster 2636* (F). CHEHALIS CO.: on trees near Aberdeen, Apr. 1909, *Foster* (MIN). COUNTY UNKNOWN: on trees, *Calkins* (MIN); Washington Territory, *Davis* (BSNH).

OREGON: WALLOWA CO.: on branches of fir, Wallowa Mountains, between Cove and Minam River, elev. 5100 ft., Sept. 21, 1897, *Sheldon* (FM,US). COUNTY INDEFINITE: on rails and trees, *Calkins* (FM); Coast Range, May 1905, *Buhl 5* (FM); Cascade Mountains, *Hall 18* (FM).

CALIFORNIA: SAN BERNARDINO CO.: pine crest, San Bernardino Mountains, Aug. 1912, *Hasse* (F); dead brush of yellow pine, San Bernardino Mountains, elev. 4500 ft., May 23, 1932, *Reed* (MBG). SAN DIEGO CO.: branches of dry scrub oak, 3 miles north of Alpine, June 1932, *Cota* (US); shady dry limbs, Manzanita brush, elev. 4500 ft., 1932, *Cota* (US); Ward Canyon, Feb. 1933, *Cota* (FM). LOS ANGELES CO.: on *Rhamnus*, Santa Catalina Island, Nolava Canyon, June 30, 1920, *Nuttall 514* (FM); on [*Quercus ?*] "Macrocarpa" bark, head of Benedict Canyon, Santa Monica Mountains, elev. 1200 ft., Mar. 14, 1933, *Wheeler 1554* (US). SAN JOAQUIN CO.: Castle Rock Ridge, Aug. 10, 1906, *Herre* (MBG). MONTEREY CO.: Monterey, 1790, *Menzies* (probably Co-type) (T); on branches of *Pinus radiata*, Rat Hill, Point Lobo Reserve, elev. 130 ft., Aug. 1, 1936, *Wheeler* (MBG). SANTA CLARA CO.: trees and shrubs, Black Mountain, elev. 1500–2785 ft., July 6, 1903, *Herre 122* (MIN,MBG); on trees, Kings Mountain, Purisima Creek, elev. 1900 ft., July 24, 1903, *Herre 179* (MIN); on fences, 4 miles west of Stanford University, elev. 400 ft., Oct. 1, 1903, *Herre 338* (MIN,MBG). SAN MATEO CO.: abundant on trees and fences along summit of range, Kings Mountain, May 19, 1902, *Baker* (WIS). SANTA CRUZ CO.: on old fences along summit of range, Santa Cruz Mountains, elev. 2000–2200 ft., Apr. 5, 1905, *Herre 633* (MBG,MIN). GLENN CO.: on trees, Plaskett Meadows, 8 miles southeast of Mendocino Pass, July 12, 1938, *Ownbey & Ownbey* (MBG). MARIN CO.: on trees, Mar. 29, 1893, *Howe* (US,MIN,WIS); on trees, Apr. 5, 1893, *Howe* (F,MBG). COUNTY UNKNOWN: on *Pinus insignis* and oaks, 1864, *Bolander* (FM,US); on rails and trees, *Calkins* (FM).

The plant is entirely western and alpine in its distribution. It is typical when found in the more humid sections of the redwood forests in California and Oregon. Those plants which come from the arid regions of California are small and depauperate. Collections of this plant are distinguishable from *P. physodes* by the larger size of the narrow lobes, the lack of soredia, and brown rather than gray color.

4. Parmelia lophyrea Ach., Meth. Lich. 198. 1803.

Parmelia cribellata Tayl., Hook. London Jour. Bot. **6**: 164. 1847.

Acharius' description was based on Menzies' collection from near Gray's Harbor, Washington. The type is in his herbarium at Helsinki, Finland. The type for Taylor's plant was Menzies' collection, and probably co-type material is now in the Taylor Collection at the Boston Society of Natural History, in Boston.

Thallus small, greenish-gray to ashy, loosely adnate to bark of trees and shrubs; upper surface smooth or occasionally with scattered white soredia, lobes long, narrow, branched, margins cut, crenate, tips somewhat inflated; lower surface black and roughened, with reticulate pits or perforations; apothecium sessile, 3–8 mm. diameter, disk concave, reddish-brown; amphithecium entire and not sorediate; K, yellowish-green, C, none, K + C, none, P, none.

Algal layer continuous, 6–18 μ thick; upper cortex 15–18 μ thick, matrix dark brown, cells in the corticellular hyphae small; medulla of loosely interwoven hyphae, tending to form cavities in older portions of the thallus and at the tips of the lobes, hyphae all of one type, 1–3 μ in diameter, hyaline; lower cortex 65–68 μ thick, cells of hyphae rectangular, octagonal or spherical, 6–9 μ in diameter, matrix brown; thecium 21–24 μ thick, hypothecium hyaline, 6–8 μ thick; ascus short-cylindrical, spores 8, spherical, 3 × 3 or 4 × 4 μ; paraphyses very small in diameter, branched.

Distribution: collected only in the Olympic Mountains of Washington.

WASHINGTON: CHEHALIS CO.: Westport, Apr. 1908, *Foster 509a* (F); Nov. 22, 1904, *Foster* (F). CLARKE CO.: Vancouver's Voyage, 1790–1792, *Menzies* (Co-type collection) (T); northwest coast, 1835–36, *Nuttall* (T).

Menzies' collection in Taylor's Herbarium of the Boston Society of Natural History is the same as Tuckerman's, but it bears the determination of *Parmelia cribellata* Taylor, of which it is the type.

5. Parmelia encausta (Sm.) Ach., Meth. Lich. 202. 1803.

Lichen encaustus Sm., Trans. Linn. Soc. London **1**: 83. 1791.

Imbricaria encausta DC. apud Lam. & DC., Fl. Fr. ed. 3, **2**: 394. 1815.

Parmelia physodes var. *encausta* Fries, Lichenogr. Eur. Reform., 64. 1831.

Smith's type is no longer in existence, but he gives the drawing in Trans. Linn. Soc. London 1: *t. 4, f. 6.* Acharius' type is in his herbarium in Upsala, Sweden; he cites as synonymous with his plant Smith's *Lichen encaustus,* Trans. Linn. Soc. London 1: 83. 1791. DeCandolle's type is not in existence, but he gives Smith's *Lichen encaustus* as a synonym of it. Fries cites *Lichen encaustus* and also lists Moug. & Nestl., Stirpes Crypt. 353, as his type.

Parmelia encausta (Sm.) Ach. is found on rocks in the alpine regions of both North America and Europe. It is distinguished from *Parmelia physodes* (L.) Ach. by the narrowness of the lobes and the size of the spores.

Thallus small, adnate to rocks, lobes long, narrow, dichotomously branched, imbricated, tips lighter-colored than the thallus, a dense layer of narrow, secondary, dichotomously branched, imbricated lobes arising from the central portion of the thallus; under surface brown at the margins, becoming dark brown or black at the center, rough; apothecium sessile, 1–6 mm. diameter; amphithecium with slightly concave crenulate margin; no chemical reaction with either K, C, or P.

Algal layer of scattered gonidia 5–6 μ in diameter; upper cortex 9–10 μ thick; medulla loosely interwoven, hyphae small and of one type; lower cortex 30–40 μ thick; thallus 120–180 μ thick; thecium 45–50 μ thick, hypothecium 18–20 μ thick; ascus clavate, 8-spored, spores 4–7 × 5–9 μ, hyaline; paraphyses branched.

The external appearance of the plant is similar to *P. centrifuga* except that it is smaller and darker in color.

Distribution: Labrador to North Carolina, west to Alberta and Montana.

LABRADOR: on rock, Capstan Island, Aug. 1, 1889, *Waghorne 32* (MIN).
NEWFOUNDLAND: on rocks, *Waghorne* (MBG, FM).
NEW HAMPSHIRE: COUNTY UNKNOWN: on rocks, *Willey* (FM).
NORTH CAROLINA: FORSYTH CO.: Winston-Salem, May 1, 1926, *Schallert* (BPI).
MONTANA: LEWIS & CLARK CO.: bark of Douglas fir, near Helena, Dec. 1931, *Flint* (MONT).
ALBERTA: on rocks, Mount Fairview, elev. 9000 ft., Aug. 9, 1906, *Fink* (F).

FOREIGN AND LOCAL EXSICCATAE EXAMINED: Desm. ed. I. ser. I. *1493;* ed. II. ser. I. *1593;* Erb. I, *119;* Funck, I, *374;* Harm. *66;* Harm. Lich. Loth. *319;* Hav. *222;* Lojk. Univ. *63;* Moug. et Nest. *353;* Roum. *40;* Stenh. *67;* Wartm. *740.*

EUPARMELIA

III. **Parmelia** subgenus **Euparmelia** Nyl. apud Hue, Revue de Bot. **4**: 375. 1885–86.

Nylander's type of the subgenus is *Parmelia caperata* (L.) Ach.

Thallus foliose, under-surface never with a thick, rough, black, lower cortex, rhizinae always present, either evenly distributed or at the points of contact with the substratum; medulla of loosely interwoven hyphae, never with a cavity or a central strand. The subgenus is world-wide in its distribution.

KEY TO SECTIONS OF EUPARMELIA

A. Rhizinae small and evenly distributed.
  B. Thallus dark, some shade of brown.....*Melanoparmelia*
  B. Thallus light, some shade of yellowish-green.....*Xanthoparmelia*
A. Rhizinae large.
  B. Rhizinae evenly distributed.....*Hypotrachyna*
  B. Rhizinae at points of contact with substratum, margins nude....*Amphigymna*

KEY TO SPECIES IN EUPARMELIA SECT. MELANOPARMELIA

A. With coralloid branchlets or soredia.
  B. Lobes broad, always wider than long.
    C. Amphithecium and upper surface hispid.....9a. *olivacea* var. *aspidota*
    C. Always sorediate .....11. *conspurcata*
  B. Lobes narrow, always longer than wide.
    C. Marginal lobes fibrillose, cylindrical.....6. *pubescens*
    C. Marginal lobes never fibrillose or cylindrical.
      D. Lobes variously branched, imbricated at tips.....8. *prolixa*
      D. Lobes digitately branched, tips rounded.....12. *exasperata*
A. Without coralloid branchlets or soredia.
  B. Lobes broad, always wider than long.
    C. No reaction with either K or C.
      D. Spores always 8.....9. *olivacea*
      D. Spores 16–24 or more.....10. *multispora*
    C. Chemical reaction, K, yellow, C, red.....9b. *olivacea* var. *glabra*
  B. Lobes narrow, always longer than wide.....7. *stygia*

I. MELANOPARMELIA

Parmelia subgenus **Euparmelia** sect. I. **Melanoparmelia** (Hue) Zahlbr. apud Engl. & Prantl, Nat. Pflanzenfam. 1 Teil, Abt. **1**: 212. 1907.

Parmelia sect. *Melanoparmelia* Hue, Nouv. Arch. du Mus. Paris, I, **4**:138. 1899.

The type of the section is *Parmelia stygia* (L.) Ach.

Thallus greenish-brown to blackish, under-surface sparingly covered with rhizinae; apothecia sessile.

6. Parmelia pubescens (L.) Wainio, Meddel. Soc. Fauna & Fl. Fenn. **14**: 22. 1888.

Lichen pubescens Linn., Sp. Pl. 83. 1753.

Cornicularia pubescens Ach., Lichenogr. Suec. Prodr. 217. 1798.

Wainio's type is *Lichen pubescens* in the Linnean Herbarium, London, England. The type locality is in the mountains of Europe. Linnaeus based his name on the plant in his herbarium. Acharius' type is in his herbarium at Upsala, Sweden. He cites as synonyms *Lichen pubescens* Linn. and *Lichen lanatus* Wulf. apud Jacq. (Misc. Aust. **2**: *t. 10, f. 5.* 1778).

The lichen has a limited distribution on the mountains of North America and Europe. It has often been misdetermined because of the fibrillose character of the margins of the thallus.

Thallus small, loosely attached, somewhat ascending; upper surface smooth, black, lobes long, round or slightly flattened on the under side, dichotomously branched, much imbricated, those at center of thallus wrinkled; lower surface smooth, lighter in color than the upper surface, rhizinae small; apothecium sessile, 0.5–1 mm. diameter, disk flat, dark brown or black, margin of amphithecium smooth; K, brown, C, none, K + C, none, P, none.

Algal layer in the center of the lobes, very thin and scattered in the flattened portions at the center of the thallus; upper cortex 3 μ thick, matrix yellow-brown; medulla loosely interwoven and with a central cavity; lower cortex 6 μ thick, lower edge much roughened; thickness of thallus 60–80 μ; thecium 55–60 μ thick; ascus clavate, 8-spored, spores 4–5 × 4–6 μ; paraphyses branched.

Distribution: Labrador, west to Washington, south to California.

LABRADOR: on rocks, Bath Harbor, June 25, 1892, *Waghorne 71* (MIN); on rock, Early Harbor, July 29, 1892, *Waghorne 170* (MIN).

NEWFOUNDLAND: on rock, Aug. 25, 1852, *Waghorne* (MBG).

MONTANA: TETON CO.: Observation Mountain, Black Foot Indian Reservation, Aug. 25, 1897, *Williams 107* (NYBG); on basalt rocks and occasionally on bark of yellow pine, near Fort Wright, Apr. 8, 1934, *Flint* (MONT).

COLORADO: COUNTY UNKNOWN: 10,000 ft. elev., May 1880, *Brandegee 115* (BSNH).

BRITISH COLUMBIA: on rocks, summit of Mount Benson, July 10, 1893, *Macoun* (MBG).

WASHINGTON: SPOKANE CO.: on basaltic rocks, near Crater Basin, Dec. 1909, *Bowser 88* (F). YAKIMA CO.: Mount Adams, *Suksdorf 147* (BSNH). KLICKITAT CO.: thin earth over boulder, Goldendale, 1909, *Foster 135* (WIS,FM). COUNTY UNKNOWN: on rocks, *Calkins 354* (F).

OREGON: COUNTY UNKNOWN: *Hall* (MBG,FM).

CALIFORNIA: TUOLUMNE CO.: rocks at Clawel's resort above Yosemite Valley, elev. 6000 ft., Apr. 1900, *Hasse 571* (NYBG).

FOREIGN EXSICCATAE EXAMINED: Malme, *405; P. lanata* Erb. I *1221;* Fellm. *82;* Harm. Lich. Loth. *315;* Hav. *181;* Roum. *558;* Wartm. *741; P. pubescens* f. *minuscula* Fellm. *83.*

7. Parmelia stygia (L.) Ach., Meth. Lich. 203. 1803.

Lichen stygius Linn., Sp. Pl. 1143. 1753; Ach., Lich. Suec. Prodr. 109. 1798.

Lobaria stygia Hoffm., Deutschl. Fl. **2**: 154. 1795.

Imbricaria stygia DC. apud Lam. & DC., Fl. Fr. ed. 3, **6**: 189. 1815.

Acharius' and Linnaeus' types are not in either herbaria at present. Acharius (Lich. Suec. Prodr.) cites as synonyms of his plant *Lobaria stygia* Hoffmann, 'Enum. Lich.,' *t. 14, f. 2.* 1784, and *Squamaria stygia* Hoffmann, 'Descr. & Adumbrat. Pl. Lich.' **2**: *t. 25, f. 2.* 1794. DeCandolle considers *Parmelia stygia* (L.) Ach., 'Meth. Lich.' 203. 1803, and *Lobaria stygia* Hoffm. 'Enum. Lich.,' *t. 14, f. 2,* the same as his plant. The plants figured by Hoffmann came from the alpine regions of Europe, and should be considered as typical.

Thallus small, loosely adnate to rock, irregular in outline; upper surface smooth, brown or shining black, lobes long, narrow, flat, irregularly branched and twisted, often convex, tips raised, upper cortex brown; under surface black, wrinkled, and with many short black rhizinae; apothecium sessile, 2–4 mm. diameter, disk slightly concave or flat, dark brown; amphithecium crenulate, slightly lobed; K, none, C, none, K + C, none, P, none.

Algal layer continuous, 15–20 μ thick; upper cortex 15–16 μ thick, matrix yellow; medulla very loosely interwoven, hyphae large and of one type; lower cortex 15–18 μ thick; hypothecium 30–33 μ thick; ascus clavate, 8-spored, spores 3–4 × 5–8 μ; paraphyses branched and clubbed at the tip.

Distribution: Newfoundland to New York, west to Alberta and Washington.

NEWFOUNDLAND: on rock, Venison Trickle, Oct. 15, 1893, *Waghorne 17* (MBG); on cliff, Lark Harbor, Bay of Hand, Mar. 21, 1890, *Waghorne* (MBG); Sparrible Cove, Apr. 20, 1899, *Waghorne* (MBG).

MAINE: PISCATAQUIS CO.: on rocks, Mount Katahdin, July 1856, *Blake* (FM).

NEW HAMPSHIRE: COOS CO.: White Mountains, alpine region, 1863, *Mann* (FM); White Mountains, 1885, *Farlow 428* (F); Mount Moriah, Sept. 1885, *Farlow* (F); Mount Washington, Sept. 1894, *Farlow* (MBG,FM); on rocks, Mount Lafayette, *Hall 41* (FM).

VERMONT: LAMOILLE CO.: on ledges, The Nose, region of Mount Mansfield, June 24, 1922, *Merrill* (F).

NEW YORK: ESSEX CO.: on rocks, Mount Marcy, near Lake Placid, elev. 5300 ft., Aug. 10, 1933, *Lowe 2601* (F).

ALBERTA: Mount Fairview, elev. 9000 ft., *Fink* (F).

MONTANA: FLATHEAD CO.: Columbia Falls, Apr. 25, 1893, *Williams* (US).

COLORADO: MONTROSE CO.: on rocks, elev. 5400 ft., Naturita, Oct. 1914, *Payson* (F); BOULDER CO.: on rocks, Mar. 1898, *Morgan* (F).

WASHINGTON: CLARKE CO.: on rocks of Pinnacle Peak, elev. 7200 ft., Sept. 8, 1909, *Foster 1055* (F).

LOCAL AND FOREIGN EXSICCATAE EXAMINED: Bartl. Dec. IV *7;* Desm. ed. I, ser. I *1942,* ed. II, ser. I *1592;* E. Fries, *166, 307, 337;* Funck, II *107;* Gar. I *8;* Harm. *67;* Harm. Lich. Loth. *313;* Hav. *182;* Leight. *365;* Malme, *66;* Moug. et Nest. *315;* Nyl. Lich. Mont. Dor. *29;* Nyl. Pyr. *17;* Stenh. *71;* Tuck. *17.*

The species is found only in the northern and alpine regions of the northern hemisphere. It grows only on rocks, and its small size and shining dark brown or black narrow lobes make it distinct in appearance from either *P. pubescens* or *P. prolixa.*

8. Parmelia prolixa (Ach.) Röhl., Deut. Fl. **3,** Abt. 2: 100. 1813.

Parmelia olivacea var. *prolixa* Ach., Meth. Lich. 214. 1803.

Röhling's type is in Acharius' herbarium and is the plant used by Acharius as the type of his *Parmelia olivacea* var. *prolixa.* The type collection was made from a plant growing in the mountains of northern Europe.

Thallus small, loosely adnate; upper surface wrinkled and with coralloid branchlets, brown or blackish-brown, lobes short, much divided, imbricated and dissected, tips slightly inflated; under surface black with many short, black, flat rhizinae; apothecium sessile, 2–5 mm. diameter, disk flat or slightly concave, brown, margin crinkled, finely lobed; K, upper cortex yellow-green, medulla brown, C, none, K + C, none, P, none.

Algal layer continuous, 10–15 μ thick; upper cortex 21–22 μ thick; medulla loosely interwoven, hyphae large and of one type; lower cortex 20–22 μ thick; thallus 350–400 μ thick; thecium 60–64 μ thick; ascus clavate, 8-spored, spores spherical, 3 × 3 or 4 × 4 μ; paraphyses branched.

Distribution: Labrador to West Virginia, west to Oregon.

LABRADOR: Packs Harbor, Hamilton Inlet, July 15, 1882, *Waghorne 13* (MBG,MIN).

NEWFOUNDLAND: on rock, sand beach, White Bay, Oct. 5, 1891, *Waghorne 355* (MIN); on rocks, Sparrible Cove, White Bay, Apr. 20, 1894, *Waghorne* (MIN).

NEW BRUNSWICK: on rocks, July 1879, *May* (FM).

MAINE: PISCATAQUIS CO.: on rocks in woods, side of Mount Katahdin, 1863, *Blake* (FM). KNOX CO.: Rockland, Sept. 20, 1915, *Merrill* (F).

NEW YORK: ESSEX CO.: on beech trees, elev. 1200 ft., June 20, 1905, *Merrill* (F).

WEST VIRGINIA: POCAHONTAS CO.: Dunmore, 1924, *Gray L309* (F).

MINNESOTA: LAKE CO.: on rocks, Snowbank Lake area, July 20, 1897, *Fink 832* (MIN); on rocks, Beaver Bay, July 13, 1897, *Fink 703* (MIN). CARLTON CO.: on rocks, Carlton Peak, July 10, 1897, *Fink 574* (MIN). KOOCHICHING CO.: on rocks, Gunflint, June 30, 1897, *Fink 290* (MIN). AITKIN CO.: on rocks, Palisades, July 15, 1897, *Fink 743* (MIN). RENVILLE CO.: on rocks, rare, Morton, July 7, 1899, *Fink 315* (MIN). YELLOW MEDICINE CO.: on wood, Granite Falls, July 11, 1899, *Fink 405* (MIN). PIPESTONE CO.: on pipestone, Pipestone, July 19, 1899, *Fink 643* (MIN). COUNTY UNKNOWN: on rocks, Blueberry Island, July 13, 1901, *Fink 575* (MIN); on rocks, South Fowl Lake, June 26, 1897, *Fink 197* (MIN); on rocks, Misquah Hills, June 5, 1897, *Fink 491* (MIN).

COLORADO: BOULDER CO.: on siliceous rocks, Longs Peak, Rocky Mountain National Park, elev. 12,600 ft., Sept. 17, 1933, *Kiener* (MBG).

WASHINGTON: CLALLAM CO.: on rocks, Sequim, 1916, *Grant* (F). ISLAND CO.· Whidbey Island, *Grant 3158* (F).

OREGON: COUNTY UNKNOWN: on trees, *Lloyd* (FM).

FOREIGN EXSICCATAE EXAMINED: Claud. *261;* Fl. Hung. *19;* Hav. *444;* Lojk. Hung. *119;* Malme, *133;* Meresch. *4;* Moug. et Nest. *1428;* Nyl. Pyr. *54;* Roum. *186;* Roum. Gen. *27;* Zw. *569, 913.*

Parmelia prolixa (Ach.) Röhl. is found growing on stones and trees throughout most of the northern part of North America and Europe. It is distinguished from *Parmelia olivacea* (L.) Ach. by the dissected character of the lobes and the yellow-green reaction of the upper cortex when treated with K.

9. **Parmelia olivacea** (L.) Ach., Meth. Lich. 213. 1803.

Lichen olivaceus Linn., Fl. Lap. 244. 1737; Sp. Pl. 1143. 1753.

Lobaria olivacea Hoffm., Deutschl. Fl. **2**: 150. 1795.

Imbricaria olivacea DC. apud Lam. & DC., Fl. Fr. **2**: 393. 1815.

Parmelia subolivacea Nyl. apud Hasse, Bull. Torr. Bot. Club **24**: 445. 1897.

The type of Linnaeus from the 'Flora Lapponica,' is unknown, but that from the 'Species Plantarum' is in his herbarium at London, England. Acharius' type is in his herbarium at Upsala, Sweden. Acharius cites as the same as his plant *t. 24, f. 77* of Dillenius, 'Historia Muscorum,' Hoffmann, 'Enumeratio Lichenum,' *t. 13, f. 3 & 4,* and Linnaeus' 'Species Plantarum,' 1143. Hoffmann's type is unknown but he cites as equal to his plant Linnaeus, 'Species Plantarum,' 1143, and Hoffmann, 'Enumeratio Lichenum,' *t. 13, f. 3 & 4.* DeCandolle considered his plant the same as Linnaeus' and Acharius' and he lists as a synonym the illustrations in Dillenius, 'Historia Muscorum' *(t. 24, f. 77).* Nylander's type of *P. subolivacea* is in the Nylander herbarium at Helsinki, Finland. The type collection of *P. subolivacea* was made by Dr. Hasse from rocks in the San Gabriel Mountains of California, and a co-type collection is in the United States National Herbarium at Washington, D. C.

The types of the European collectors came from the northern part of Europe. The species is distributed widely in the northern portions of both Europe and North America.

Thallus small to medium-sized, 3–10 cm. diameter, adnate to bark of trees; upper surface much wrinkled; cortex unbroken, olive-brown in color; apothecium sessile, 1–4 mm. diameter, disk concave, olive-brown, amphithecium slightly incurved, roughened with tiny lobules; K, none, C, none, K + C, none, P, yellow.

Algal layer continuous, 20–22 μ thick; upper cortex 18–21 μ thick, with yellow-brown matrix; medulla loosely interwoven with one type of hyphae; lower cortex 5–7 μ thick, with black matrix; thallus 144–150 μ thick; thecium 30–35 μ thick; ascus clavate, 8 spores to an ascus, spores 3–4 × 5–6 μ; paraphyses branched simply.

Distribution: Newfoundland to New York, west to California.

NEWFOUNDLAND: on rock, Sparrible Cove, Apr. 21, 1899, *Waghorne 81* (MBG); on trees, Capstan Island, Oct. 3, 1889, *Waghorne 203* (MIN); on bark, Chappel, Trinity Bay, July, 1883, *Waghorne 27* (MIN); on rocks, White Bay, May 10, 1891, *Waghorne* (MBG).

QUEBEC: on mountain ash, Lac Trois Saumons, May 13, 1936, *Lepage 303* (MBG); on Norway pine, Ste. Anne, Apr. 29, 1936, *Lepage* (MBG).

ONTARIO: on trees, islands in Lake Nipigon, July 11, 1884, *Macoun* (WIS); trees, Big Island, July 1894, *Millan & Sheldon 22458* (MIN); Collins Inlet, Algona District, Sept. 12, 1912, *Klugh* (F); on alder stem and fence rails in Ontario and on the former in British Columbia, 1878, *Macoun 24* (WIS,MBG).

MAINE: AROOSTOCK CO.: on cherry trees, St. Francis, Aug. 1893, *Cummings & Teller 26* (MBG,WIS,FM,F,MIN). KNOX CO.: on rocks, Rockport, May 7, 1910, *Merrill 136* (NYBG,MIN). CUMBERLAND CO.: Cumberland, 1863, *Blake* (FM).

NEW HAMPSHIRE: CARROLL CO.: Chocorua, Aug. 1911, *Farlow 478* (WIS); on trees, Chatham, July 1905, *Riddle* (F). COOS CO.: White Mountains, *Willey* (MIN). CHESHIRE CO.: Monadnoc, *Russell* (FM).

VERMONT: ADDISON CO.: on yellow birch, Goshen, elev. 1500 ft., Dec. 21, 1922, *Dutton* (MBG). ORLEANS CO.: Elephants Head, June 18, 1883, *Faxon* (WIS).

MASSACHUSETTS: BRISTOL CO.: trunks and rocks, common but infertile, New Bedford, *Willey 27* (FM). NORFOLK CO.: on smooth bark, Wellesley, Oct. 1907, *Riddle* (F).

NEW YORK: YATES CO.: Dundee, *Wright 11* (FM); Penn Yan, *Buckley* (MBG).

OHIO: ASHTABULA CO.: on rails and apple trees, Orwell, Apr. 27, 1895, *Bruge 863* (NYBG). ATHENS CO.: on oak, Sept. 22, 1935, *Wolfe 493* (O). FAIRFIELD CO.: on poplar, Sept. 22, 1935, *Wolfe* (NYBG). PIKE CO.: on linden, Sept. 15, 1935, *Wolfe 488* (O).

MICHIGAN: MACKINAC CO.: on beech, Mackinac Island, July 1899, *Harper* (F); on *Fagus ferruginea*, Mackinac Island, July 11, 1899, *Harper & Harper 68* (FM). KEWEENAW CO.: on birch, Rock Harbor, Isle Royale, Aug. 1904, *Harper & Harper* (FM); on *Populus*, Isle Royale, July 26, 1904, *Harper & Harper 169* (FM); on *Alnus*, Rock Harbor, Isle Royale, July 19, 1904, *Harper & Harper 176* (FM); Isle Royale, July 9, 1901, *Stuntz & Allen* (WIS). COUNTY UNKNOWN: Sailors Encampment, Aug. 3, 1897, *Harper & Harper* (FM).

WISCONSIN: ASHLAND CO.: on trees, Oak Island, July 10, 1901, *Fink* (MIN); VILAS CO.: valley of the Wisconsin River, near Lac Vieux Desert, Summer 1893, *Cheney 69* (WIS). BARRON CO.: Barron, Apr. 3, 1930, *Cheney 13022* (WIS). RACINE CO.: valley of the Wisconsin River near Lenwood Ferry, Summer 1894, *Cheney 3586* (WIS).

ILLINOIS: MENARD CO.: Athens, *Hall* (WIS,FM); limbs of *Quercus alba*, high up, Athens, Mar. 1862, *Hall* (FM). LA SALLE CO.: on trees, *Calkins* (FM).

MINNESOTA: COOK CO.: on alder, Grand Marais, July 22, 1902, *Fink 5160* (MIN); on balsam, Grand Marais, July 22, 1902, *Fink 5152* (MIN); on alder, Grand Marais, July 22, 1902, *Fink 5157* (MIN); on rocks along the lake, Grand Marais, Aug. 5, 1902, *Fink 5296* (MIN); on trees, Grand Portage, June 18, 1897, *Fink 11* (MIN). LAKE CO.: on trees, Beaver Bay, July 13, 1897, *Fink 712* (MIN); on trees, Snowbank Lake area, July 20, 1897, *Fink 848* (MIN). ST. LOUIS CO.: on bark, Vermilion Lake, Lat. 48°, July 20, 1886, *Arthur, Bailey & Holway A80* (MIN); on trees, Ely, July 28, 1897, *Fink 1004* (MIN); Tower, Aug. 20, 1901,

Fink 1859 (MIN); Harding, Aug. 20, 1901, *Fink 1623* (MIN); on trees, Tower, Aug. 23, 1901, *Fink 1588* (MIN). CARLTON CO.: on trees, Tafte, Carlton Peak, June 10, 1897, *Fink 585* (MIN); on trees, Tafte, Carlton Peak, July 10, 1897, *Fink 591* (MIN); on rocks, Kettle Falls, Aug. 9, 1901, *Fink 1337* (MIN). KOOCHICHING CO.: on trees, Koochiching, July 25, 1901, *Fink 889* (MIN); on rocks, Rainy Lake City, Aug. 8, 1901, *Fink 1206* (MIN); Rainy Lake City, Aug. 8, 1901, *Fink 1281* (MIN); on trees, Rainy Lake City, Aug. 8, 1901, *Fink 1167* (MIN); on trees, Rainy Lake City, Aug. 30, 1901, *Fink 1162* (MIN). HENNEPIN CO.: on bark, Minnehaha, Apr. 1891, *Sheldon S4115* (MIN). BLUE EARTH CO.: on trees and old wood, Mankato, June 23, 1899, *Fink 61* (MIN). BELTRAMI CO.: on tamarack in swamp, frequent, Red Lake, July 30, 1900, *Fink 991* (MIN); on wood, Lake of the Woods, July 1896, *Millan 6* (MIN); on trees in tamarack swamp, frequent, Bemidji, July 7, 1900, *Fink 513* (MIN); on rocks, Bemidji, July 4, 1900, *Fink 446* (MIN); on rocks along the lake, Red Lake, Aug. 1, 1900, *Fink 1039* (MIN); on balsam in swamps, Beaudette, June 1, 1901, *Fink 56* (MIN); on oaks, frequent, Bemidji, July 4, 1900, *Fink 443* (MIN). OTTERTAIL CO.: on trees, Leaf Hills, June 26, 1900, *Fink 243* (MIN); Battle Lake, June 19, 1900, *Fink 31* (MIN). YELLOW MEDICINE CO.: on trees, Granite Falls, July 15, 1899, *Fink 537* (MIN). ROSEAU CO.: on trees, Warroad, June 25, 1901, *Fink 141* (MIN). PENNINGTON CO.: on trees, Thief River Falls, July 20, 1900, *Fink 830* (MIN).

IOWA: FAYETTE CO.: on trees, Aug. 1893, *Fink* (WIS); on trees, Aug. 1898, *Fink* (MIN); on trees, 1896, *Fink* (MBG).

ALBERTA: on *Salix*, Banff, *Sanson* (F).

MONTANA: YELLOWSTONE CO.: bark of live *Alnus tenuifolia*, Buffalo Creek, Helena National Forest, Sept. 10, 1931, *Flint* (MONT); bark of Douglas fir and on dead *Salix*, Bear Gulch, Helena National Forest, S.20. T.7. N. R 4 E., July 28, 1931, *Flint* (MONT). COUNTY UNKNOWN: on alder, Lower Pattee Canyon, Jan. 15, 1934, *Flint* (MONT).

WYOMING: ALBANY CO.: Sheep Mountain, July 3, 1897, *A. Nelson* (MBG). NATRONA CO.: Willow Creek, May 22, 1897, *E. Nelson* (MBG).

NEW MEXICO: SOCORRO CO.: shade, San Andres Mountains, Rhodes Pass, 47 miles west of Tularosa, June 6, 1938, *Hubricht B999* (MBG). VALENCIA CO.: shade, 7 miles north of Trechado, June 9, 1938, *Hubricht B1069* (MBG); open woods, 16 miles south of El Morro, June 10, 1938, *Hubricht B1105* (MBG). MCKINLEY CO.: pine-juniper forest, 22 miles south of Gallup, June 11, 1938, *Hubricht B1140* (MBG).

BRITISH COLUMBIA: on bark of tree, June 1915, *Macoun 15* (F); Lillocet, July 1915, *Macoun 456* (F).

WASHINGTON: PIERCE CO.: on alder, Longmires Springs, Aug. 1906, *Harper & Harper* (FM). ISLAND CO.: on *Alnus*, 1923, Langley, *Grant* (WIS). WHITMAN CO.: on lower dead branches of yellow pines, along Palouse River near Palouse, Aug. 12, 1938, *Ownbey & Ownbey* (MBG).

OREGON: COUNTY UNKNOWN: on *Alnus oregona*, 1921, *Grant* (FM).

CALIFORNIA: SAN BERNARDINO CO.: on oaks, Wildwood Canyon above Yucaipa Valley, Mar. 24, 1936, *Reed* (MBG); on oak, San Bernardino Range, July 1895, *Hasse* (FM). RIVERSIDE CO.: on oaks, San Jacinto Mountains, elev. 1600 ft., 1903, *Hasse 103* (MIN). MONTEREY CO.: on rock, Dells Camp, San Antonio Canyon, 1894, *Hasse* (F). MARIPOSA CO.: on rocks, Yosemite, May 11, 1896, *Cummings* (WIS).

SAN JOAQUIN CO.: on mossy sandstone, Castle Rock, elev. 3000 ft., June 16, 1906, *Herre 744* (MIN); on sandstone, Castle Rock, elev. 3000 ft., Dec. 3, 1904, *Herre* (MBG); on sandstone, Castle Rock, elev. 3000 ft., June 10, 1906, *Herre* (MBG). BUTTE CO.: hills 4 miles east of Chico, on *Quercus Douglasii*, Jan. 28, 1914, *Heller 11160* (MIN,MBG). SANTA CLARA CO.: on *Quercus Wislizenii*, Black Mountain, elev. 1600 ft., *Herre* (MBG). COUNTY UNKNOWN: on oaks, Ano Nuevo Creek, elev. 100 ft., Aug. 9, 1906, *Herre* (MIN).

9a. Parmelia olivacea var. **aspidota** Ach., Meth. Lich. 214. 1803.

Lichen aspidotus Hoffm., Enum. Lich., *t. 13, f. 5.* 1784.

Parmelia aspidota Röhl., Deut. Fl. **3**, Abt. 2: 100. 1813.

Acharius' type of the variety is no longer in existence, but he cites Hoffmann, 'Enum. Lich.,' *t. 13, f. 5.* 1784, and Dillenius, 'Historia Muscorum,' *t. 24, f. 78.* 1741. Röhling cites as the type of his plant, Acharius, Meth. Lich. 214. 1803.

The variety is widely distributed in the northern portions of the temperate zones. It is distinguished from the species by the abundant covering of granules and coralloid branchlets on the upper surface of the thallus and the margin of the apothecium. Thalloid characters of such a nature do not merit the rank of species.

Distribution: Newfoundland to North Carolina, west to New Mexico.

NEWFOUNDLAND: sandstone, White Bay, May 10, 1891, *Waghorne* (MBG); Trinity Bay, Mar. 21, 1883, *Waghorne* (MBG).

NEW BRUNSWICK: bark of trees, 1871, *Fowler* (FM).

ONTARIO: on trees, islands in Lake Michigan, July 11, 1884, *Macoun* (MBG); on cedars in swamp, Emo, July 17, 1901, *Fink 667* (MIN).

VERMONT: COUNTY UNKNOWN: *Pringle* (BSNH).

MASSACHUSETTS: COUNTY UNKNOWN: Crawford Path, June 5, 1882, *Faxon* (F).

NEW YORK: YATES CO.: Penn Yan, *Buckley* (MBG).

NORTH CAROLINA: COUNTY INDEFINITE: on trees, mountains of North Carolina, *Calkins 377* (FM).

OHIO: COUNTY UNKNOWN: on bark of tree, *Bogue* (FM).

MICHIGAN: WASHTENAW CO.: on aspen, Whitmore Lake, May 16, 1931, *Lowe* (M). ALCONA CO.: on aspen, Mud Lake Bog, May 16, 1931, *Lowe* (M).

WISCONSIN: WAUSHARA CO.: west of Coloma, Oct. 13, 1935, *J. Thomson* (WIS). LAFAYETTE CO.: Fayette, July 15, 1894, *Cheney 9206* (WIS).

ILLINOIS: MENARD CO.: high up in hickory trees, 1878, *Hall* (FM,MBG,BSNH).

MINNESOTA: BELTRAMI CO.: on trees, Bemidji, July 12, 1900, *Fink 672* (MIN). OTTERTAIL CO.: on trees, Leaf Hills, July 2, 1900, *Fink 385* (MIN). PIPESTONE CO.: on quartzite, Pipestone, July 18, 1899, *Fink 621* (MIN). COUNTY UNKNOWN: Oak Island, July 9, 1901, *Fink 464* (MIN).

IOWA: FAYETTE CO.: on trees, 1896, *Fink* (MBG,F,WIS,MIN).
MONTANA: CASCADE CO.: Great Falls, Mar. 31, 1888, *Williams 25* (MIN).
COLORADO: EL PASO CO.: on live elm, Palmer Lake, June 20, 1928, *Laidig* (F).
NEW MEXICO: SAN MIGUEL CO.: on trees, Las Vegas, Feb. 18, 1926, *Bro. Anect* (M).

9b. Parmelia olivacea var. **glabra** (Schaer.) Linds., Trans. Roy. Soc. Edinb. **12**: 236. 1859.

Parmelia olivacea corticola* var. *glabra* Schaer., Lich. Helv. Spic. sect. 10: 466. 1840.

Both Schaerer and Lindsay considered Schaerer's 'Lich. Helv. Exs.' 370, the type of this variety. The variety differs from the species only in that the medulla becomes red with $CaOCl_2$.

Distribution: North American collections of the plant have been seen from only a few localities in southern California.

CALIFORNIA: SAN BERNARDINO CO.: on oaks, elev. 1600 ft., June 1899, *Hasse 265* (F); on mossy sandstone, elev. 3000 ft., Castle Rock, June 16, 1906, *Herre* (F,MBG). LOS ANGELES CO.: on rocks, Camp Baldy, elev. 4700 ft., *Hasse* (F).

10. Parmelia multispora Schneid., Guide to Study of Lichens, 154. 1898.

Parmelia olivacea var. *multispora* Merrill, Bryol. **12**: 73. 1909.

Parmelia olivacea var. *polyspora* Herre, Proc. Wash. Acad. Sci. **12**: 199. 1910.

Schneider's type is a plant collected in the mountains east of San Francisco in California, and is now in the United States National Herbarium. Merrill's type is in his herbarium at Harvard University, and is probably co-type material from Schneider. Herre's type is number 426 in the Lichen Herbarium at Leland Stanford University.

Thallus small, 3–7 cm. diameter, adnate, lobes wide and short, little-branched, margins smooth; upper surface smooth or slightly wrinkled, olive-brown or almost black; under surface brown and smooth at the margins, black at the center, with numerous short black rhizinae; apothecia numerous, sessile, 1–8 mm. diameter, disks flat to slightly concave, chestnut-brown or darker, amphithecia thin, smooth; K, none, C, none, K + C, none, P, none.

Algal layer continuous, 4–8 μ thick; upper cortex 8–10 μ thick, matrix brown; medulla loosely interwoven; lower cortex 12–16 μ thick, matrix black; thickness of thallus 48–120 μ; thecium 60–65 μ thick, ascus clavate, spores 16 to many, spherical, 1–4 μ diameter; paraphyses branched, enlarged at the tips.

Distribution: Idaho, west to British Columbia, south to California.

IDAHO: BONNER CO.: on *Salix*, Cooling, Sept. 18, 1919, *Weir* (F).

BRITISH COLUMBIA: trunks of trees, Sidney, Vancouver Island, 1912, *Macoun* (F).

WASHINGTON: KLICKITAT CO.: on oaks, Goldendale, Oct. 16–23, 1919, *Foster* (F). SPOKANE CO.: on alders, Dead Man Creek, *Bowser* (F).

OREGON: MARION CO.: Salem, 1871, *Hall* (FM).

CALIFORNIA: LOS ANGELES CO.: San Gabriel Mountains, 1906, *Hasse* (F); on oak, Garapito Canyon, Santa Monica Mountains, Sept. 1, 1920, *Moxley 802* (BPI). MARIPOSA CO.: on oak, Yosemite Valley, 1900, *Riddle* (F). SANTA CLARA CO.: on oak, Black Mountain, Santa Cruz Mountains, Apr. 30, 1904, *Herre* (BPI,MIN); on *Quercus Wislizenii*, Black Mountain, Santa Clara Mountains, elev. 1600 ft., Apr. 30, 1904, *Herre 426* (Type of variety) (LSU).

11. Parmelia conspurcata (Schaer.) Wainio, Meddel. Soc. Fauna & Fl. Fenn. **24**: 22. 1888.

Parmelia olivacea var. *corticola* f. *conspurcata* Schaer., Lich. Helv. Spic., sect. 10: 466. 1840.

Schaerer took as the type of the form of his variety, Lich. Helv. Exs. 371, which was collected in the Swiss Alps. Wainio, using the same type, raised the form to the rank of a species.

Thallus small to large, 2–10 cm. diameter, loosely adnate, gray to olive-brown or greenish-gray; upper surface wrinkled, covered with small soredia, margin crinkled, slightly sorediate, lobes round, short, slightly and irregularly dissected; lower surface brown to black, with few black rhizinae; apothecium, sessile, 4–7 mm. diameter, margin slightly lobed and sorediate, disk concave, chestnut-brown; K, greenish-yellow then brown, C, none, K + C, red, P, none.

Algal layer continuous, 12–15 μ thick; upper cortex 15–16 μ thick, matrix yellow; medulla loosely interwoven, hyphae of one type; lower cortex 15–20 μ thick, matrix brown or black; thecium 36–45 μ thick; ascus clavate, spores 5–7 × 10–14 μ, hyaline; paraphyses branched and knobbed at the tip.

Distribution: Alberta to British Columbia, south to California.

ALBERTA: on white spruce, Banff, Oct. 1, 1910, *Sanson 323* (F).
BRITISH COLUMBIA: "Biglon Bay," New Denver, Dec. 25, 1920, *MacFadden 127* (BPI).
CALIFORNIA: SAN MATEO CO.: on sandstone, elev. 1900 ft., Bear Gulch road, Santa Cruz Mountains, May 12, 1904, *Herre 488* (F,MBG,MIN); on rocks and mosses, elev. 1000–1300 ft., San Bruno Mountain, July 13, 1906, *Herre 835* (MBG,MIN).

12. Parmelia exasperata (Ach.) DeNot., Giorn. Bot. Ital., 2: 193. 1847.

Collema exasperatum Ach., Lichenogr. Univ. 645. 1810.

Acharius' type was from the Valley of St. Nicolai in Switzerland. DeNotaris, using material determined by Acharius, placed the species in the genus *Parmelia*.

Thallus small, 3–8 cm. diameter, adnate on stone or wood, wrinkled, smooth and shining or granular, lobes long, narrow, tips rounded, tightly appressed, imbricated, olive-brown to olivaceous-black; K, none, C, none, K + C, none, P, none.

Algal layer continuous, 70–75 μ thick; upper cortex 15–20 μ thick; medulla loosely interwoven, hyphae of one type; lower cortex 15–20 μ thick, matrix brown; thickness of thallus 180–200 μ; thecium 30–35 μ thick; ascus clavate, spores 8, 2–3 × 4–6 μ; paraphyses branched.

Distribution: Maine to West Virginia, west to California.

MAINE: KNOX CO.: on trunks of trees, Camden, Sept. 1904, *Merrill* (F).
NEW HAMPSHIRE: MERRIMACK CO.: on old fence, North Sutton, July 1914, *Riddle 1427* (F).
WEST VIRGINIA: POCAHONTAS CO.: Wanless, Jan. 1923, *Gray L231* (F).
OHIO: WAYNE CO.: on *Pyrus Malus*, Wayne, Apr. 2, 1895, *Bogue 778* (NYBG).
MICHIGAN: CHEBOYGAN CO.: vicinity of Burt and Douglas lakes, June-Aug. 1911, *Leeson* (F).
CALIFORNIA: COUNTY INDEFINITE: on *Quercus*, Tehachapi Mountains, June 1907, *Hasse* (BPI). MARIPOSA CO.: on tree, Yosemite Valley, 1900, *Hasse* (F). SANTA CLARA CO.: on rocks, hills near Stanford, elev. 150 ft., Apr. 9, 1904, *Herre* (MBG).

II. XANTHOPARMELIA

Parmelia subgenus **Euparmelia** sect. **II. Xanthoparmelia** Zahl. apud Engler & Prantl, Nat. Pflanzenfam. I Teil, Abt. 1: 212. 1907.

Parmelia sect. *Xanthoparmelia* Wainio, Étude Lich. Brèsil **1**: 60. 1890.

Wainio considered *Parmelia endoleuca* Taylor as the type of the section *Xanthoparmelia*. Zahlbruckner considered *Parmelia conspersa* (Ehrh.) Ach. as the type for section *Xanthoparmelia* of *Euparmelia*.

Thallus small, lobes narrow and imbricated; lower surface with small rhizinae, apothecia sessile.

KEY TO SPECIES IN EUPARMELIA SECT. XANTHOPARMELIA

A. Thallus light-colored below.
  B. Lobes wider than long; spores spherical, 4 × 4.5–5 × 5 μ....16. *sphaerosporella*
  B. Lobes longer than wide.
    C. Spores 7–10 × 9–12 μ.....19. *leucochlora*
    C. Spores 3–4 × 5–7 μ.....14. *centrifuga*
A. Thallus always dark below.
  B. Never with soredia, isidia, or coralloid branchlets.
    C. Never on soil.
      D. Upper surface always smooth, uncracked; spores 4–6 × 7–9 μ.... .....17. *conspersa*
      D. Upper surface always cracked; spores 7–10 × 12–16 μ.....18. *lineola*
    C. Always on soil, often drifted into piles by the wind.....15. *chlorochroa*
  B. Always with soredia, isidia, or coralloid branchlets.
    C. With isidia or coralloid branchlets; K, yellow...17a. *conspersa* var. *isidiata*
    C. With yellow globose powdery soredia; K, brown.....13. *incurva*

13. Parmelia incurva (Pers.) Fries, Nova Sched. Crit. 31. 1826.

Lichen incurvus Pers., Neue Ann. d. Bot. **7**: 24. 1794.

Lobaria incurva Hoffm., Deutschl. Fl. **2**: 156. 1795.

Imbricaria incurvus Ach., Lichenogr. Suec. Prodr. 107. 1798.

Persoon's type is unknown, but probably came from near Leyden, as the plant has a wide distribution throughout Europe. Hoffmann cites *Lichen incurvus* Pers. as synonymous with his *Lobaria incurva*. Acharius' *Imbricaria incurvus* was described from material collected in the mountains of Europe. He cites Persoon's *Lichen incurvus* and Hoffmann's *Lobaria incurva* as being synonymous with his plant. Fries cites all three of the previous treatments in transferring the species to the genus *Parmelia*.

Thallus small, 5–15 cm. diameter, adnate on stones, margins

yellowish-green with center dark greenish-gray, lobes long and very narrow, imbricated, the tips appressed; cortex smooth except for scattered, globular, powdery, yellow soredia; undersurface dark brown with short, thick, black rhizinae evenly distributed, the tips of which are fused into a continuous layer of some extent; apothecium sessile, 3–10 mm. diameter, margin smooth and entire, disk concave to flat, chestnut-brown; K, upper cortex black, medulla brown, C, none, K + C, none, P, none.

Algal layer discontinuous, gonidia in clumps 60–75 μ in diameter; upper cortex 60–75 μ thick, matrix brown; lower cortex 60–70 μ thick, matrix black; medullary hyphae loosely interwoven, hyphae all of one type, 1–2 μ in diameter; thickness of thallus 1000–1017 μ; thecium 55–65 μ thick; ascus short-cylindrical, spores 8, 5–6 × 8–14 μ; paraphyses branched once or twice.

Distribution: Newfoundland to New Hampshire and Vermont.

NEWFOUNDLAND: on rock, Chance Cove, Trinity Bay, 1882, *Waghorne* (MBG); on rocks, east coast, July 20, 1891, *Waghorne 36* (MIN).

MAINE: KNOX CO.: on quartzite rocks, elev. 900 ft., Camden, Aug. 22, 1909, *Merrill 75* (MIN).

NEW HAMPSHIRE: COOS CO.: on rocks, White Mountains, 1854, *Tuckerman* (T).

VERMONT: WINDSOR CO.: table rock, Mount Horrid, Rochester, elev. 2500 ft., Sept. 17, 1902, *Dutton 1415* (FM).

FOREIGN AND LOCAL EXSICCATAE EXAMINED: E. Fries, *260*; Harm. *69*; Harm. Lich. Loth. *278*; Hav. *78, 314, 390*; Malme, *178*; Merr. *75*; Norrl. et Nyl. *27*; Roum. *433*; Salw. *237*; Stenh. *123*; Tuck. *76*.

14. Parmelia centrifuga (L). Ach., Meth. Lich. 206. 1803.

Lichen centrifugus Linn., Sp. Pl. 1142. 1753.

Imbricaria centrifuga Ach., Lichenogr. Suec. Prodr. 118. 1798.

Linnaeus based his *Lichen centrifugus* on European material in his herbarium. Acharius says that he saw the Linnaean plants and considered them the same as his *Parmelia centrifuga*.

Thallus small, light yellow-green above, orbicular, closely adnate to rocks; upper cortex free from isidia or soredia, margins always smooth, lobes dichotomously branched, narrow,

with rounded closely appressed tips; lower surface light-colored with numerous, small, light-brown rhizinae evenly distributed; apothecium sessile, 2–7 mm. diameter, disk convex, chestnut-brown, margin somewhat incurved and smooth; K, upper cortex lemon-yellow, medulla yellow, C, none, K + C, yellow, P, none.

Algal layer continuous, immediately beneath the upper cortex, 35 μ thick; medulla of loosely interwoven hyphae 1 μ or less in diameter, with no differentiation into a medullary strand or central cavity; upper cortex 14 μ thick with vertically extending hyphae surrounded by a yellowish-green matrix; lower cortex 28 μ thick, composed of vertically interwoven hyphae with a black matrix; thecium 33–35 μ thick; ascus pyriform, spores 8, 3–4 × 5–7 μ, arranged irregularly; paraphyses branched, tips slightly enlarged.

Distribution: Labrador to Tennessee, west to Alaska and British Columbia.

LABRADOR: on boulders and other rocks, Aug. 27, 1896, *Low* (F); rocks, coast of north Labrador, Aug. 23, 1896, *Low* (F).

NEWFOUNDLAND: on rocks, White Bay, Oct. 1, 1891, *Waghorne 359* (MIN); on rocks, Harbor Deep, White Bay, Nov. 1, 1891, *Waghorne* (MBG); on rocks, Tanners Head, Mar. 4, 1892, *Waghorne* (MBG); on rocks, Corke Rock, July 12, 1893, *Waghorne* (MBG).

NEW BRUNSWICK: on rocks, Lobewue River, July 1884, *Hay* (F).

QUEBEC: on rocks, Ste. Anne, Apr. 23, 1935, *Lepage 146* (D); among dry granite rocks at 1200 m., northeast summit of Mount Dunraven, Tabletop Mountains, Aug. 1, 1923, *Fernald, Dodge & Smith* (D); on rocks at Rimouski, May 22, 1937, *Lepage 512* (D).

MAINE: PENOBSCOT CO.: on rocks, New Port, July 27, 1922, *Plitt* (BPI). KNOX CO.: on quartz, Camden, elev. 900 ft., Aug. 22, 1909, *Merrill 75* (F); on ledges at 900 ft. elev., Camden, Aug. 24, 1909, *Merrill 96* (MIN).

NEW HAMPSHIRE: COOS CO.: Gate of Notch, June 16, 1883, *Faxon* (WIS); alpine regions, White Mountains, 1863, *Mann* (FM); Mount Washington, July 1884, *Faxon* (FM); White Mountains, Sept. 1909, *Farlow 430* (F); White Mountains, *Willey 46* (MIN). GRAFTON CO.: summits of Mounts Lincoln and Lafayette, Franconia Mountains, Aug. 15, 1892, *Cummings & Heller 107* (MBG,WIS,FM).

VERMONT: LAMOILLE CO.: ledges, the Chin, Mount Mansfield, elev. 5000 ft., June 20–24, 1922, *Dutton* (MBG).

NEW YORK: ESSEX CO.: on rocks, Mount Marcy, near Lake Placid, 5000 ft., Aug. 16, 1934, *Lowe 4197* (NYBG).

PENNSYLVANIA: LANCASTER CO.: on rocks, Bear Town, July 11, 1894, *Eby* (MBG).

TENNESSEE: HAMILTON CO.: on rocks, Lookout Mountain, *Calkins 7* (F).

MINNESOTA: ST. LOUIS CO.: on rocks, Misquah Hills, July 5, 1897, *Fink 496a* (MIN).

COLORADO: CLEAR CREEK CO.: above Bear Creek, elev. 12,000 ft., July 6, 1896, *Pammel* (MBG).

ALASKA: Arakamlchetchene Island, Behring Strait, *Wright* (F).

YUKON: on rocks, Bonanza Creek, July 18, 1902, *Macoun 24* (F).

BRITISH COLUMBIA: on rocks, back of Glain House, elev. 4450 ft., Aug. 6–7, 1906, *Fink 5866* (M).

FOREIGN AND LOCAL EXSICCATAE EXAMINED: Cum. I. *107;* Elenk. *102a, b;* Fellm. *80;* E. Fries, *48;* Th. Fries, *6;* Howe, *28;* Lojk. Univ. *158;* Malme, *67;* Meresch. *54;* Merr. *96;* Norrl. et Nyl. *202;* Rab. *471;* Stenh. *125;* Tuck. *78;* Zw. *450.*

15. Parmelia chlorochroa Tuck., Proc. Amer. Acad. Arts & Sci. **4**: 383. 1860.

Tuckerman's type was collected on the upper Missouri River near the mouth of the Cannon Ball River by Hayden. This plant is now in Tuckerman's herbarium, at Harvard University.

Thallus small, 2–4 cm. diameter, growing on arid soil, loose and easily blown about by the wind, lobes long, narrow, repeatedly dichotomously branched, somewhat imbricate, convex, whitish-gray to yellowish-gray; under surface dark brown or black with small black rhizinae evenly distributed; apothecia rare, sessile, 2–6 mm. diameter, disks concave to flat, dark brown, amphithecia smooth or crenulate, slightly incurved at the margin; K, upper cortex yellow, medulla none, C, none in either the upper cortex or medulla, K + C, medulla brown, P, yellow.

Algal layer discontinuous, in groups of cells which are 25–40 μ in diameter; upper cortex 28–30 μ thick; medulla of loosely interwoven hyaline hyphae; lower cortex 20–25 μ thick; thallus 266–506 μ thick; thecium 48–60 μ thick; ascus clavate, spores 8, 3–4 × 6–8 μ; paraphyses thin, branched.

Distribution: North Dakota to Nebraska, west to Saskatchewan and New Mexico.

NORTH DAKOTA: MORTON CO.: on ground, abundant on right side of Missouri River near Cannon Ball River, *Hayden* (Type Collection) (F).

SOUTH DAKOTA: PENNINGTON CO.: Black Hills, Upper Pole Creek, Aug. 1856, *Engelmann* (MBG); on dry earth among rocks, Dakota, 1907, *Skinner* (MIN); on eroded clay soil, Rapid City, Mar. 20, 1927, *McIntosh* (M,F). WASHINGTON CO.: abundant on dry soil, Indian Draw, July 18, 1911, *Fisher 2127* (FM).

NEBRASKA: SIOUX CO.: on dry calcareous soil near War Bonnet Canyon, June 20, 1890, *Williams 106* (F,MBG,FM,MIN).

SASKATCHEWAN: on earth, Old Wives Creek, May 25, 1895, *Macoun* (MBG).

MONTANA: CASCADE CO.: on soil, slightly northwest, Great Falls, Mar. 22, 1932, *Flint* (MONT). LEWIS AND CLARK CO.: on soil, very abundant on windswept site, bluffs, east shore of Lake Sewell, Helena, elev. 4000 ft., Oct. 1931, *Flint* (MONT). BEAVERHEAD CO.: growing on dry gravelly soil in sagebrush near Bannack, June 1926, *Flint* (MONT).

WYOMING: ALBANY CO.: Laramie, July 23, *A. Nelson* (MBG); hills 6 or 7 miles east of Laramie, Nov. 15, 1936, *G. Ownbey* (MBG). JOHNSON CO.: on the floor of the Devil's Kitchen, Powder River, June 27, 1910, *A. Nelson* (MBG). CARBON CO.: gravelly hills on the ground, 60 miles from foothills, *Hall* (FM); full sun, 1 mile north of Bairoil P.O., June 30, 1938, *Hubricht B1304* (MBG). WASHAKIE CO.: in crevices of boulders, Soldiers Park, North Fork of Clear Creek, Big Horn Mountains, Aug. 19, 1898, *Williams* (MBG). FREMONT CO.: Wind River Mountains, 1860, *Hayden* (T). LINCOLN CO.: on earth, Gros Ventre Canyon, July 19, 1939, *Andrews* (MBG). CONVERSE CO.: full sun, 7 miles northeast of Orin, July 1, 1938, *Hubricht B1314* (MBG).

COLORADO: CLEAR CREEK CO.: Rocky Mountains, *Hall* (T); Empire, July 1895, *Bethel* (W). GUNNISON CO.: Rogers Bridge, 1878, *Brandegee* (F). PARK CO.: on earth, South Park, 1873, *Wolf* (FM). CHAFFEE CO.: Mount Garfield, elev. 3700 m. Sept. 8, 1901, *Clements & Clements* (NYBG). JACKSON CO.: Black Water of the Platte, *Engelmann* (T). ROUTT CO.: on earth, Mount Meadow, *Calkins 343* (FM).

NEW MEXICO: VALENCIA CO.: full sun, on ground, 16 miles south of El Morro, June 10, 1938, *Hubricht B1107* (MBG); full sun, on ground, 7 miles north of Trechado, June 9, 1938, *Hubricht B1085* (MBG). CATRON CO.: full sun, on ground, 11 miles north of Pie Town, June 9, 1938, *Hubricht B1064* (MBG).

LOCAL EXSICCATAE EXAMINED: Merr. *237*; Cum. I *106*, II *27*.

Parmelia chlorochroa Tuck. is endemic in the Rocky Mountains and Great Basin region of North America. In the literature and herbaria it has been confused with *Parmelia molliuscula* Ach. and *vagans* Nyl. Acharius' *Parmelia molliuscula* was named from a sterile collection made by Thunberg on Table Mountain, South Africa. Nylander discusses collections from Siberia, Peru, and North America as representing *Parmelia vagans;* these are not the same as Tuckerman's *Parmelia chlorochroa.*

16. Parmelia sphaerosporella Müll.-Arg., Flora **74**: 378. 1891.

The type was collected by Dr. Lyall in the Galton Mountains of British Columbia, and sent to the Kew Herbarium as the Plants of the Oregon Boundary Commission.

Thallus small, 4–8 cm. diameter, adnate to substratum; upper surface much wrinkled but not broken, margins appressed, round, smooth, lobes short and wide, not branched, upper surface golden-yellow, medulla white; lower surface light (white or yellow with many thick, light-colored rhizinae); lower cortex much wrinkled but not cracked or broken; apothecia numerous, 1–6 mm. diameter, sessile, concave, light-brown; margin of amphithecium thin, smooth, and unbroken; K, none, C, none, K + C, none, P, red-brown.

Algal layer continuous, 25–35 μ thick; upper cortex 20–25 μ thick; medulla very loosely interwoven, hyphae hyaline, rough and of one type, 4–6 μ in diameter; lower cortex 20–25 μ thick, matrix light-colored or hyaline; thickness of thallus very variable, 400–1000 μ; thecium 60–64 μ thick, hypothecium hyaline, 48–60 μ thick; algal layer continuous under the thecium; ascus cylindrical or slightly clavate, spores 8, spherical, 4 × 4.5–5 × 5 μ; paraphyses branched and enlarged at the tips.

Distribution: Ontario and British Columbia.

ONTARIO: on trees, Emo, July 18, 1901, *Fink 684* (MIN).

BRITISH COLUMBIA: Galton Mountains, Oregon Boundary Commission, 1861, *Lyall* (Co-type collection) (F,LSU).

17. Parmelia conspersa (Ehrh.) Ach., Meth. Lich. 205. 1803.

Lichen conspersus Ehrh. in litt. apud Ach., Lichenogr. Suec. Prodr. 118. 1798.

Imbricaria conspersa Ach., Lichenogr. Suec. Prodr. 118. 1798.

Ehrhart based his description on the plants in the Linnean Herbarium. Acharius cites Ehrhart's plant as synonymous with his *Imbricaria conspersa* and *Parmelia conspersa*. Hoffmann's use of *L. centrifugus* to designate the plant is non valid, as *centrifuga* had already been applied to another plant of the group.

Thallus large, wide-spread, adnate to substratum; upper surface smooth, without cracks, isidia or soredia, margins always smooth, bright green to yellowish-brown; lobes short, with margins much but not deeply dissected, either dichotomously or irregularly branched, arising from the center of the

thallus and growing out over the lower thallus, often forming several layers; lower surface black or brown, much wrinkled, lower cortex continuous, rhizinae evenly distributed, but papillose; apothecium sessile, 1–5 mm. diameter, concave, disk chestnut-brown; amphithecium slightly incurved, with few vertical fissures on the margin; K, yellow, C, none, K + C, none, P, red-brown.

Algal layer continuous with slight lobing at the lower side, 35–50 μ thick; upper cortex of vertical hyphae with a dark matrix, 6.5–7 μ thick; thallus 133–171 μ thick; lower cortex 36–60 μ thick; medullary hyphae loosely interwoven, with no suggestion of a central strand or central cavity, two types of medullary hyphae, the common type small, less than 1 μ in diameter and hyaline, and a few scattered dark hyphae 2–3 μ in diameter; thecium 100–125 μ thick; ascus clavate, spores 8, 4–6 × 7–9 μ; paraphyses branched and slightly flattened at the tips.

Distribution: Newfoundland to Alabama, west to Washington and California.

NEWFOUNDLAND: on sea cliff, Half-way Point, Bay of Hand, Apr. 29, 1897, *Waghorne 315* (MIN); on rocks, Jan. 3, 1899, *Waghorne* (MBG).

NEW BRUNSWICK: Grand Hirman, July 1879, *May* (FM); Owen Sound, *Hall* (FM).

QUEBEC: on rock, Ste. Anne, May 5, 1935, *Lepage 148* (D); on boulder, Ste. Anne, May 5, 1935, *Lepage 47* (D).

ONTARIO: on boulders in woods and open places, Ottawa, Oct. 16, 1892, *Macoun 155* (WIS,MBG); on boulders in pastures, Apr. 27, 1903, *Merrill* (MBG); on rocks, Algonquin Park, July 12, 1900, *Macoun 247* (MBG); on rocks, Emo, July 22, 1901, *Fink 814* (MIN).

MAINE: CUMBERLAND CO.: on rock and stones, Cumberland, Nov. 30, 1855, *Blake* (FM). HANCOCK CO.: Mount Desert Island, July 25, 1928, *Plitt* (BPI); Mount Desert Island, Middle Triad Summit, Sept. 1894, *Rand* (D).

NEW HAMPSHIRE: COOS CO.: Mount Shelburne, Cabot, June 9, 1844, *Schrenk* (MBG). CHESHIRE CO.: on shaded rock, Jaffrey, Aug. 1916, *Riddle* (F).

VERMONT: ADDISON CO.: cedar trees in swamp, Leicester, Feb. 11, 1910, *Dutton 337* (FM); on huge boulder, Middlebury, Apr. 26, 1913, *Dodge 155* (D); on quartz, Middlebury, May 10, 1913, *Dodge 148* (D). RUTLAND CO.: on wood-shingled roof, Brandon, Sept. 14, 1910, *Dutton 471* (FM).

MASSACHUSETTS: ESSEX CO.: on rock, Annisquam, Apr. 2, 1892, *Cummings* (MBG,MIN,WIS,FM); Marblehead, July 12, 1895, *Harper & Harper 36* (FM). MIDDLESEX CO.: Concord, 1863, *Mann* (FM); on rocks, Arlington, Apr. 15, 1895, *Fink* (MBG). SUFFOLK CO.: near Boston, *Faxon* (WIS). NORFOLK CO.: Wellesley, Nov. 18, 1883, *Cummings 56982* (W). BRISTOL CO.: on old wood, New Bedford, 1862–1898, *Willey* (US); on rocks, New Bedford, *Willey 42* (FM,MIN).

NEW YORK: JEFFERSON CO.: vicinity of Fishers Landing, July 3, 1902, *Robinson & Maxon 80* (FM). YATES CO.: rocks, Quarry Hill, Penn Yan, Sept. 1850, *Buckley* (MBG).

PENNSYLVANIA: PIKE CO.: Matamoras, Sept. 24, 1896, *Schneider* (MIN). CHESTER CO.: on rocks, 1878, *Rothrock* (FM). LANCASTER CO.: on rocks, Chestnut Hill, June 1893, *Eby* (MBG); on rocks, Mar. 1884, *Eby* (MBG).

DELAWARE: NEWCASTLE CO.: on dry rocks, Faulkland, Feb. 7, 1887, *Cummons* (NYBG).

MARYLAND: MONTGOMERY CO.: rock outcrop, west knoll, Plummers Island in Potomac River, near Cabin John, Nov. 6, 1938, *Leonard* (US); rocks, Sligo Creek, 1900, *Williams* (US,WIS). PRINCE GEORGES CO.: rocks in stream, Oct. 5, 1935, *Schulz* (M).

DISTRICT OF COLUMBIA: *Lugger* (MIN).

NORTH CAROLINA: DAVIDSON CO.: on exposed rock, Friedberg section, July 1, 1922, *Schallert* (WIS). CHATHAM CO.: on exposed rock, Bennetts Stone Quarry, May 3, 1929, *Schallert* (WIS).

FLORIDA: ORANGE CO.: on *Quercus*, Sanford, Apr. 1922, *Rapp* (BPI).

ALABAMA: LEE CO.: on rock, Auburn, Feb. 20, 1897, *Earle & Baker* (MBG,MIN).

MICHIGAN: KEWEENAW CO.: on stones, Isle Royale, July 1904, *Harper & Harper 112* (FM). COUNTY UNKNOWN: Sailors Encampment, Aug. 22, 1899, *Harper & Harper 39* (FM); loosely covering rocks, Sailors Encampment, Aug. 27, 1899, *Harper & Harper 27* (FM).

OHIO: HOCKING CO.: on sandstone boulders, Oct. 20, 1935, *Wolfe 355* (O). JACKSON CO.: on sandstone at edge of cliff, May 6, 1934, *Wolfe & Couep* (O). ATHENS CO.: on rock, Apr. 4, 1936, *Wolfe 567* (O).

INDIANA: CRAWFORD CO.: on sandstone rock, along Little Blue River near old Canes Mill, about 2 miles south of Grantsburg, June 7, 1929, *Deam 46* (BPI).

TENNESSEE: HAMILTON CO.: on rocks, Lookout Mountain, *Calkins 3* (MBG); on rocks, Lookout Mountain, *Calkins 7* (MIN); Lookout Mountain, *Calkins 1* (FM).

WISCONSIN: RACINE CO.: Valley of the Wisconsin River, near Linwood Ferry, Summer 1894, *Cheney 3485* (WIS). ADAMS CO.: bluffs, 10 miles east of Friendship, Sept. 13, 1935, *Thomson* (WIS).

ILLINOIS: JACKSON CO.: on sandstone boulders near Bat Cave, 5 miles southwest of Pomona, Apr. 14, 1940, *Hubricht B1735* (MBG).

MINNESOTA: COOK CO.: on rocks, Grand Portage Island, June 23, 1897, *Fink 103* (MIN); on rocks, Grand Marais, July 24, 1902, *Fink 5208* (MIN). LAKE CO.: on rocks, Snowbank Lake area, July 27, 1897, *Fink 967* (MIN). ST. LOUIS CO.: on rocks, Harding, Aug. 19, 1901, *Fink 1602* (MIN); on rocks, Tower, Aug. 24, 1901, *Fink 1743* (MIN). CARLTON CO.: on rocks, Tafte, Carlton Peak, July 10, 1897, *Fink 621* (MIN); on rocks, Kettle Falls, Aug. 9, 1901, *Fink 1330* (MIN). KOOCHICHING CO.: on rocks, Gunflint, June 30, 1897, *Fink 289* (MIN); on rocks, Palisades, July 15, 1897, *Fink 755* (MIN). BLUE EARTH CO.: on rocks, Mankato, June 26, 1899, *Fink 105* (MIN). LAKE OF THE WOODS CO.: Lake of the Woods, July 1896, *Millan 2* (MIN); BELTRAMI CO.: on granite, Bemidji, July 16, 1900, *Fink 745* (MIN). YELLOW MEDICINE CO.: on rocks, Granite Falls, July 12, 1899, *Fink 449* (MIN). ROSEAU CO.: on the big rock, Warroad, July 4, 1901, *Fink 368* (MIN). PENNINGTON CO.: on exposed granite rock, Thief River Falls, July 20, 1900, *Fink 832* (MIN). CLAY

CO.: on rocks, Ulen, July 5, 1899, *Fink 269* (MIN). COUNTY UNKNOWN: on rocks, Blueberry Island, July 13, 1901, *Fink 567* (MIN); on rocks, Misquah Hills, July 5, 1897, *Fink* (MIN).

IOWA: CLAYTON CO.: on sandstone, Sept. 1894, *Fink* (MIN). POWESHIEK CO.: in protected but not disintegrated places on sandstone, Grinnell, Mar. 13, 1904, *Fink 147* (FM). LYON CO.: on rocks, northwest corner, Aug. 6, 1896, *Shimek* (IA); on rocks, northwest corner of county, near White farm, June 1897, *Shimek* (IA).

MISSOURI: WAYNE CO.: on granite rocks, Clark Mountain, *C. Russell* (MBG). ST. LOUIS CO.: on rocks, Ranken Estate, Apr. 30, 1939, *Berry* (MBG). IRON CO.: on exposed rocks, top of Pilot Knob, Dec. 1900, *C. Russell* (MBG); full sun to semi-shade, Royal Gorge, 3 miles east of Arcadia, Nov. 19, 1939, *Hubricht B1721* (MBG). ST. FRANCOIS CO.: on rocks, open woods, Koester, June 10, 1939, *Hubricht B1501* (MBG); surface of sandstone ledge, glade, Pickle Springs, May 21, 1938, *Berry* (MBG). WASHINGTON CO.: exposed limestone cliffs, Vineland, Mar. 1898, *C. Russell 137* (MBG). FRANKLIN CO.: on limestone ledges, Gray Summit, Nov. 15, 1936, *Berry* (MBG). REYNOLDS CO.: on granite rocks, north fork of Black River, Nov. 18, 1938, *Schmitt* (MBG). GREENE CO.: rocky wooded bank of James River, 8 miles south of Springfield, Apr. 7, 1939, *Dodge, Berry & Johnson* (MBG).

ARKANSAS: WHITE CO.: near Judsonia, Dec. 28, 1938, *Anderson* (MBG). BOONE CO.: rocky wooded bluff, above dry creek bed, Bear Creek Spring, .5 miles north of Francis, Apr. 7, 1939, *Dodge, Berry & Johnson* (MBG). GARLAND CO.: dry exposed rock, Hot Springs, Dec. 25, 1899, *C. Russell 15* (MBG); on rocks, open slope, North Mountain, Hot Springs, Nov. 12, 1938, *Schull* (MBG). NEWTON CO.: high bluff and long steep wooded hillside, Lookout Point, 7 miles south of Jasper, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG); steep dry wooded bluff with rocky flat top, 1 mile south of Ponca, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG).

KANSAS: DOUGLAS CO.: on sandstone, Jan. 1895, *Bridwell 111* (F).

OKLAHOMA: DELAWARE CO.: Dripping Springs, near Mosby, Apr. 19, 1936, *Fasset* (WIS).

TEXAS: BREWSTER CO.: full sun to semi-shade, Castle Rock, south end of Chisos Mountains, May 28, 1938, *Hubricht B869* (MBG); full sun to semi-shade, 18 miles south of Marathon, May 27, 1938, *Hubricht B856* (MBG). PRESIDIO CO.: full sun to semi-shade, Wire Gap, head of South Canyon, 15 miles southeast of Casa Piedra, May 30, 1938, *Hubricht B962* (MBG). CULBERSON CO.: full sun to semi-shade, Beach Mountain, 8 miles north of Van Horn, *Hubricht B963* (MBG).

WYOMING: WASHAKIE CO.: in crevices of boulders, Soldiers Park, North Fork of Clear Creek, Big Horn Mountains, Aug. 19, 1898, *Williams 316* (MBG). YELLOWSTONE PARK: 1922, *Hawkins 17a* (WIS). COUNTY INDEFINITE: Rocky Mountain Flora, Latitude 60°, *Hall* (FM).

COLORADO: EL PASO CO.: Pikes Peak, Aug. 1901, *Harper & Harper* (FM); on rocks, Colorado Springs, Sept. 6, 1904, *Clements & Clements* (MIN).

NEW MEXICO: VALENCIA CO.: on rock, semi-shade, 16 miles south of El Morro, June 19, 1938, *Hubricht B1094* (MBG).

ARIZONA: COUNTY UNKNOWN: under andesitic precipice, Barfoot Peak, Oct. 8, 1906, *Plummer 1469* (FM).

WASHINGTON: FERRY CO.: on rocks, Republic, 1913, *Foster 103* (FM).

CALIFORNIA: LOS ANGELES CO.: on rocks, moss and earth, mountain top, Santa

Catalina Island, *Nuttall 434* (FM). SANTA CLARA CO.: on rocks, Los Trancos Road, elev. 400 ft., Mar. 22, 1904, *Herre* (MIN); on rocks in foothills, elev. 150 ft., Apr. 9, 1904, *Herre 392* (MIN).

LOCAL AND FOREIGN EXSICCATAE EXAMINED: Bal. *4234;* Bartl. VIII *6;* Breut. *402;* Claud. *15;* Cromb. *26;* Cum. I *10*, II *86;* Desm. ed. II, ser. II *586;* Elenk. *54a, c;* Fellm. *79;* Flk. *34;* E. Fries *167;* Funck, II *109;* Hav. *153;* Howe, *27;* Johns. *303;* Larb. Caes. *65;* Malbr. *270;* Malme, *204;* Mand. *11;* Mass. *314;* Meresch. *55;* Merr. *251;* Norrl. et Nyl. *26;* R. & S. *11;* Roum. *44;* Salw. *144;* Schl. Cent. IV *46;* Stenh. *122;* Wain. *106;* West. *1041.*

17a. Parmelia conspersa var. **isidiata** (Anzi) Berry, n. comb.

Parmelia conspersa f. *isidiata* Anzi, Cat. Lich. Sondr. 28. 1860.

Imbricaria conspersa f. *isidiata* Arn., Flora **67**: 163. 1884.

Anzi's type of the form is Anzi, Lich. Exsic. Ital. 110. Arnold cites Anzi in transferring the form to *Imbricaria.* The type of the new combination is *Flint,* University of Montana. The new combination was made because the outgrowth of coralloid branchlets from the thallus is considered to be a character of the order of a variety. The use of the form is reserved for less specialized variations.

The upper surface of the thallus is covered with coralloid branchlets, otherwise the characters of size, habit, habitat, chemical reaction, and spore measurements are the same as those of the species.

Distribution: Nova Scotia to Tennessee, west to California.

NOVA SCOTIA: on rocks, Yarmouth, June 10, 1910, *Macoun* (MBG).

VERMONT: RUTLAND CO.: on lime rocks, Brandon, elev. 600 ft., Dec. 1, 1922, *Dutton 1970* (MBG).

MASSACHUSETTS: BRISTOL CO.: on old fence, country road, New Bedford, Dec. 1895, *Willey* (US).

TENNESSEE: HAMILTON CO.: Lookout Mountain, *Calkins 1* (MBG).

WISCONSIN: SAUK CO.: Parferys Glen, Oct. 1936, *J. Thomson* (WIS).

TEXAS: GILLESPIE CO.: Young Blood Creek, *Jermy 431* (MBG).

MONTANA: MISSOULA CO.: from rocks, Lower Pattee Canyon, Jan. 15, 1934, *Flint* (MONT). FLATHEAD CO.: on rocks at northwest corner Gravelly Range Lake, Apr. 14, 1931, *Flint* (MONT).

IDAHO: BONNER CO.: shale rock of Shoshone Range, Little Sentinel Peak, Aug. 30, 1931, *Flint* (Type of variety) (MONT); on rock, near Cabinet, Nov. 4, 1934, *Flint* (MONT).

CALIFORNIA: LOS ANGELES CO.: rough sunny lava, Puddingstone Dam, San Jose Hills, elev. 900 ft., May 5, 1933, *Wheeler 1713* (MBG).

FOREIGN EXSICCATAE EXAMINED: Johns. *221.*

18. Parmelia lineola Berry, sp. nov.

Thallus large, orbicular in outline, adnate to surface of rock; upper surface brownish-gray in the center to olive-green at the margins, much wrinkled, with many cracks in the cortex; black ostioles of the spermagonia numerous on the younger portions of the thallus; lobes narrow, subdichotomously branched, imbricated, margins thin, smooth; lower surface dark brown to black, rhizinae black, small and thinly scattered; lower cortex much wrinkled but not broken, with cracks as on the upper cortex; apothecium sessile, 1–6 mm. diameter, disk black, concave or flat, margin thin, smooth, and somewhat crinkled; K, yellow then brown, C, none, K + C, none, P, none.

Upper cortex of vertical hyphae very dense, almost pseudoparenchymatous, matrix yellow, 45–50 μ thick; algal layer discontinuous, gonidia formed of scattered groups of from 2 to 12 algal cells, located directly beneath the upper cortex; algae *Protococcus;* medulla of very loosely interwoven hyaline hyphae; lower cortex 36–38 μ thick, matrix yellow or brownish-yellow; thecium 80–85 μ thick; ascus clavate, spores 8, 7–10 × 12–16 μ, hyaline; paraphyses branched once or twice, tips enlarged.

Thallus orbiculatus ad saxa adnatus; superficies superior rugosa, cortice fisso; spermagonia numerosa in thallo juvenili; laciniae lineares, subdichotome ramosae, olivaceo-virides ad griseo-brunneae; superficies inferior nigro-brunnea ad nigra, rhizinis parvis, nigris, tenuibus, sparsis; medulla KOH addito flavescens, $CaOCl_2$, K et C addito non mutans; apothecium sessile, 1–6 mm. diametro, discus niger, concavus aut planus; amphithecum tenue, undulato-crenulatum; cortex superior densus, 45–50 μ crassitudine; algae Protococcideae; stratum gonidiale discontinuum, gonidia catenulata, 2–12 algarum cellulis; medulla laxe reticulata, hyphis hyalinis uniformibus; cortex inferior 36–38 μ crassitudine; thecium 80–85 μ crassitudine; asci clavati, sporae 8-nae, 7–10 μ crassitudine, 12–16 μ longitudine, ellipsoideae; paraphyses cum ramis binis vel ternis, apicibus dilatatis.

Distribution: Montana to Texas, west to Utah and Arizona.

TEXAS: CULBERSON CO.: full sun to semi-shade, north side of summit of Van Horn Mountains, 15 miles south of Van Horn, June 2, 1938, *Hubricht B937* (MBG).

MONTANA: FLATHEAD CO.: two and one half miles up Glen Trail east from Flathead Lake, Nov. 18, 1934, *Flint* (MONT).

WYOMING: YELLOWSTONE PARK, 1922, *Hawkins 17c* (WIS). CROOK CO.: Sundance Mountain, July 3, 1896, *A. Nelson* (MBG). FREMONT CO.: Pole Creek, July 1, 1895, *A. Nelson* (MBG). COUNTY UNKNOWN: on the rocks of the cliffs, Gibbon Meadow, July 28, 1899, *Nelson & Nelson 6192* (MIN,MBG).

NEW MEXICO: SOCORRO CO.: semi-shade, San Andres Mountains, Rhodes Pass, 47 miles west of Tularosa, June 6, 1938, *Hubricht B1006* (MBG). VALENCIA CO.: semi-shade, 7 miles north of Trechado, June 9, 1938, *Hubricht B1074* (MBG); semi-shade, 2 miles southeast of Ramah, June 10, 1938, *Hubricht B1114* (MBG). SIERRA CO.: full sun, 9 miles west of Engle, June 7, 1938, *Hubricht B1019* (MBG).

ARIZONA: APACHE CO.: on rock, open woods, 3 miles northwest of Ft. Defiance, June 12, 1938, *Hubricht B1170* (Type collection) (MBG); on log, open woods, 3 miles northwest of Ft. Defiance, June 12, 1938, *Hubricht B1181* (MBG); canyon wall, Massacre Cave, Canyon del Muerto, Aug. 14, 1939, *Cutler* (MBG).

UTAH: SAN JUAN CO.: full sun to semi-shade, 5 miles north of Blanding, June 22, 1938, *Hubricht B1223* (MBG).

19. Parmelia leucochlora Tuck., Syn. N. Amer. Lich. **1**: 64. 1882.

Tuckerman's type is the collection of Veitch made in the state of Mississippi.

Thallus oval or irregular in outline, small to medium-sized, adnate to bark of trees; upper cortex wrinkled, but free from any type of outgrowth, pale yellow or straw color above; lobes rounded, short and rather wide, deeply dissected, with the edges imbricated, lower surface olive-brown, with many small evenly distributed rhizinae of lighter color than the lower cortex; apothecia sessile, 1–5 mm. diameter, slightly concave, disks chestnut-brown, margin slightly crenate; K, medulla and upper cortex yellowish-green, C, none, K + C, none, P, none.

Algal layer continuous, slightly lobed on the under side, 60–75 μ thick; upper cortex of vertical hyphae with a yellow matrix, 30–40 μ thick; medulla of loosely interwoven hyphae of one type, 1–2 μ in diameter; lower cortex with a yellow matrix, 18–20 μ thick; thallus 280–300 μ thick; thecium 60–70 μ thick; spores 8 to an ascus, almost spherical, 7–10 × 9–12 μ, ascus clavate; amphithecium with a continuous layer of algal cells; paraphyses clavate at tips, branched once or twice.

The plant differs from *P. conspersa* (Ehrh.) Ach. in the size

of the spores, the color of the under cortex, and in chemical reaction. The distribution is definitely southern and southeastern.

Distribution: South Carolina to Florida, west to Texas.

SOUTH CAROLINA: BEAUFORT CO.: Beaufort, 1868, *Mellichamp* (T).

FLORIDA: VOLUSIA CO.: New Smyrna, Apr. 18, 1921, *Kelly* (NYBG,BPI). DUVAL CO.: on oaks, Fort George Island, *Calkins 6* (W,MBG). ORANGE CO.: on oaks, Sanford, 1905, *Rapp 18* (F). COUNTY UNKNOWN: *Miss Wilson* (BSNH).

MISSISSIPPI: COUNTY UNKNOWN: 1845, *Dr. Veitch* (Type collection) (T).

LOUISIANA: COUNTY UNKNOWN: 1853, *Hale* (T).

ARKANSAS: NEWTON CO.: steep dry wooded bluff with rocky flat at top, 1 mile south of Ponca, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG).

TEXAS: AUSTIN CO.: on cedar twigs, Austin, Apr. 1928, *Plitt 34* (BPI).

III. HYPOTRACHYNA

Parmelia subgenus **Euparmelia** sect. **III. Hypotrachyna** Zahl. apud Engler & Prantl, Nat. Pflanzenfam. I Teil, Abt. 1: 212. 1907.

Parmelia section *Hypotrachyna* Wainio, Étude Lich. Brèsil **1**: 38. 1890.

Zahlbruckner's type of the section is *Parmelia sublinearis* Wainio. Wainio's type is *Parmelia acanthifolia* Pers.

Thallus dark greenish-gray or darker, under surface black, except in *P. rudecta, P. Borreri* and *P. cubensis;* rhizinae always present and evenly distributed; medulla loosely interwoven, without a cavity, hyphae always of one type, hyaline and of small diameter. The distribution of the section is worldwide, with the greatest number of species from the tropics.

KEY TO SPECIES IN EUPARMELIA SECTION HYPOTRACHYNA

A. Thallus grayish-green or darker.
  B. Thallus light-colored below.
    C. With soredia above; K, none, C, none.....28. *rudecta*
    C. With coralloid branchlets above; K, yellow, C, red.....24. *Borreri*
  B. Thallus brown to black below.
    C. Lobes narrow.
      D. With coralloid branchlets above.
        E. Lobes more or less branched.
          F. Thallus small, with scattered black rhizinae; K, none, C, red.....34. *Finkii*
          F. Thallus large, with many black rhizinae; K, yellow, C, yellow.

G. Thallus light to dark but not black.....21. *saxatilis*
G. Thallus black and granular.....21a. *saxatilis* var. *Anzi*
E. Lobes rarely branched, sometimes bearing fibrils on upper surface; K, brown, C, yellow.....35. *caroliniana*
D. Without coralloid branchlets above.
E. Lobes dichotomously branched; K, none, C, brown.....23. *Herrei*
E. Lobes irregular or subpinnately branched.
F. Rhizinae papillose; K, none, C, none.....27. *texana*
F. Rhizinae strong, numerous.
G. Medulla sulphur-yellow; K, none, C, none.....41. *sulphurosa*
G. Medulla white; K, none, C, orange-brown.....33. *livida*
C. Lobes wide.
D. Margins flat or very slightly raised.
E. With marginal soredia or black cilia.
F. With marginal soredia; K, none, C, none.....30. *cetrata*
F. With heavy black marginal cilia; K, none, C, none.....30a. *cetrata* var. *subisidiosa*
E. Without marginal soredia.
F. Rhizinae numerous; K, red-brown, C, none.....29. *reticulata*
F. Rhizinae few; K, yellow, C, none.....26. *quercina*
D. Margins raised, under side white.
E. With marginal cilia; K, none, C, yellow.....32. *erecta*
E. Without marginal cilia; K, cortex yellow-green, medulla none, C, none.....31. *Hubrichtii*
A. Thallus pale yellowish-green to yellowish-brown.
B. Thallus yellowish-brown or darker, lobes smooth or with coralloid branchlets.....20. *omphalodes*
B. Thallus pale yellow-green to yellow-brown.
C. Lobes narrow.
D. Closely adnate.
E. Lower surface light brown; K, none.....37. *cubensis*
E. Lower surface black; K, brown.....36. *sublaevigata*
D. Loosely adnate; lower surface black.....38. *laevigata*
C. Lobes wide.
D. Upper cortex smooth, unbroken.
E. Medulla yellow, K, brown; lower surface dark.....40. *aurulenta*
E. Medulla white; K, yellow; lower surface light.....39. *endoxantha*
D. Upper cortex pitted, or reticulately sorediate.
E. Upper cortex pitted; lower surface light; K, none.....25. *Bolliana*
E. Soredia in reticulate ridges; lower surface black; K, yellow.....22. *sulcata*

20. Parmelia omphalodes (L.) Ach., Meth., Lich. 204. 1803.
Lichen omphalodes Linn., Sp. Pl. 1143. 1753.
Parmelia saxatilis var. *omphalodes* Fr., Lichenogr. Eur. Reform. 62. 1831.

Acharius' type was from Linnaeus' herbarium. The type is now in the Linnean Herbarium in London. The plant used by Linnaeus was probably collected in central Europe. Fries cites as typical plants of his variety, E. Fries, Lich. Suec. Exs. 108, and Moug. & Nest. Exs. 348.

Thallus 4–10 cm. diameter, loosely adnate to stones or rarely to firm earth, shining olive-brown to dark brown or black; upper surface rough with wrinkles and thickly covered with coralloid branchlets or granules and flat lobules, lobes long, narrow, much branched, dissected, and imbricated; lower surface wrinkled but unbroken; cortex black, numerous strong black rhizinae to the margins of the thallus; apothecium 1–4 mm. diameter, sessile, disk slightly concave or flat, chestnut-brown, margin of amphithecium covered with coralloid branchlets; K, upper cortex and medulla yellow then brown, C, none, K + C, none, P, none.

Algal layer continuous, irregular in thickness, 5–50 μ thick; upper cortex 20–24 μ thick, matrix brown; medulla loosely interwoven, hyphae of one type, hyaline; lower cortex 20–36 μ thick, matrix black or dark brown; thallus 160–180 μ thick; thecium 48–60 μ thick; ascus clavate, spores 8, 3–4 × 5–6 μ; paraphyses branched.

Collections of this species from Europe are usually larger in external respects than American collections, and very rarely have the coralloid branchlets on the upper surface. There is a tendency to form overlapping layers of the thallus which helps to distinguish this species from *Parmelia saxatilis* (L.) Ach. in the field.

Distribution: Labrador to New Hampshire, west to Alaska and British Columbia.

LABRADOR: on rocks, Red Bay, Aug. 12, 1889, *Waghorne* (US).

QUEBEC: on wet stones, Ste. Anne, Apr. 30, 1936, *Lepage 386* (MBG).

NEW HAMPSHIRE: COUNTY INDEFINITE: on rocks, mountains, *Calkins* (FM); on trees, mountains, *Calkins 376* (FM).

ALASKA: on the Arctic Ocean, ten miles east of Cape Lisbon, Aug. 22, 1880, *Bean* (FM).

BRITISH COLUMBIA: on rocks, Deer Park, Columbia River, June 1890, *Macoun 86* (WIS); on rocks, Ucluelet, Vancouver Island, July 4, 1908, *Macoun* (MBG).

21. Parmelia saxatilis (L.) Ach., Meth. Lich. 204. 1803.
Lichen saxatilis Linn., Sp. Pl. 1142. 1753.
Lobaria saxatilis Hoffm., Deutschl. Fl. **2**: 145. 1795.
Parmelia saxatilis var. *leucochroa* Wallr., Fl. Crypt. German. **3**: 499. 1831.

Linnaeus' type was a European collection, which is still in his herbarium in London. Acharius accepted this plant as the type, transferring it from the genus *Lichen* to *Parmelia*. He cites Jacquin, 'Collectanea' **4**: 281. *t. 20, f. 2.* 1790, which is designated *Lichen saxatilis*, as synonymous with his plant. Hoffmann cites Jacquin's figure as synonymous with his *Lobaria saxatilis*. The type of Hoffmann is unknown. Wallroth cites Linnaeus' plant and the figure of Jacquin as synonymous with his concept of the variety *leucochroa*.

Thallus foliose, 6–10 cm. diameter, appressed; upper surface smooth, slightly cracked or with few scattered soredia, lobes linear, narrow, imbricated, dichotomously or subdichotomously branched, margins very slightly ascending; lower surface black to the margins, rhizinae black, numerous, papillose at the margins, long at the center of the thallus; apothecium sessile, 3–10 mm. diameter, disk concave, chestnut-brown, margin crenulate, dissected irregularly and usually sorediate; K, upper cortex yellow, medulla yellowish-green then reddish-brown, C, medulla and upper cortex yellow, K + C, yellow, P, red-brown.

Algal layer continuous, 16–18 μ thick; upper cortex 24–28 μ thick; medulla of loosely interwoven hyphae of one type; lower cortex 32–33 μ thick; thickness of thallus 131–138 μ; thecium 40–44 μ thick; ascus clavate, spores 8, 8–9 × 15–16 μ; paraphyses branched, enlarged at tip; spermagonia immersed in surface of thallus lobes, spherical, walls black above, brown or hyaline below, opening by black ostioles, spermatiophores simple, spermatia fusiform.

Distribution: Newfoundland to Florida, west to Washington and California.

NEWFOUNDLAND: on trees, Bar Harbor, June 24, 1893, *Waghorne* (MBG); on rocks, Western Cove, White Bay, Dec. 11, 1891, *Waghorne* (MBG); Chance Cove,

Trinity Bay, Sept. 12, 1882, *Waghorne* (MBG); on trees, New Harbor, Sept. 21, 1893, *Waghorne 39* (MIN).

NOVA SCOTIA: on rocks, Springfield, Aug. 17, 1910, *Macoun* (F); on twigs and branches, *Rothrock* (FM).

QUEBEC: mossy woods between Lac Mont Louis and the North Fork of Madeleine River, July 31, 1923, *Fernald, Dodge & Smith* (MBG); on rocks covered by leaf mould, Ste. Anne, May 5, 1935, *Lepage 135* (D); on rocks, Ste. Anne, May 5, 1935, *Lepage 139* (D); adherent to rocks, Ste. Anne, May 11, 1935, *Lepage 115* (D); on dry rocks, Ste. Anne, May 15, 1935, *Lepage 138* (D); on boulders, Ste. Anne, May 30, 1935, *Lepage 269* (D).

ONTARIO: on rocks, Emo, July 20, 1901, *Fink 768* (MIN); quite common on trees, dead wood, and rocks, Belleville, 1871, *Macoun 73* (WIS,MIN,MBG); on trees and old logs, Ottawa, Apr. 26, 1896, *Macoun* (MBG).

MAINE: HANCOCK CO.: on rock, Mount Desert Island, Cliffwalk, Seal Harbor, July 12, 1894, *Merrill* (D). KNOX CO.: on trunks of trees, Camden, May 21, 1912, *Merrill* (WIS,MBG,FM). CUMBERLAND CO.: on trees, Cumberland, 1855, *Blake* (FM); on granite, St. Thomason, Sept. 17, 1910, *Merrill* (F).

NEW HAMPSHIRE: COOS CO.: near top of Mount Washington, Aug. 1926, *Kirk* (F).

VERMONT: WINDSOR CO.: ledges, Mount Horrid, Rochester, elev. 2700 ft., Oct. 3, 1920, *Dutton 1110* (FM); base of shaded ledges, Mount Horrid, Rochester, Oct. 3, 1920, *Dutton* (MBG). RUTLAND CO.: on dead wood, Pawlet, Mar. 22, 1913, *Dodge 157* (D).

MASSACHUSETTS: BARNSTABLE CO.: on trees, near Morrison, Cape Cod, July 14, 1937, *Berry* (MBG). ESSEX CO.: on rocks, Rockport, Apr. 7, 1899, *Cummings 274* (FM). BRISTOL CO.: on bark, New Bedford, *Willey* (MIN); on rocks and trunks, New Bedford, *Willey* (FM); on moss, New Bedford, *Willey* (MBG).

NEW YORK: ESSEX CO.: Newcomb, June 8, 1922, *House* (F). YATES CO.: on wood, Penn Yan, *Buckley* (MBG); Dundee, *Wright* (FM).

PENNSYLVANIA: PIKE CO.: Sept. 24, 1896, *Schneider* (MBG). HUNTINGTON CO.: on trees, Pennsylvania State College Nature Camp, 16 miles southeast of State College, July 23, 1937, *J. Thomson* (WIS).

VIRGINIA: LEE CO.: edge of wood, Hunters Gap, Powell Mountain, 2.7 miles north of Blackwater, Aug. 23, 1937, *Hubricht B404* (MBG).

NORTH CAROLINA: ALEXANDER CO.: on bark of tree, Mount Pisgah, Sept. 9, 1922, *Schallert 3094* (WIS). MITCHELL CO.: on rock, Roan Mountain, June 15, 1936, *Schallert* (B); on Roan Mountain, July 16, 1891, *Small* (MBG).

SOUTH CAROLINA: COUNTY UNKNOWN: on rocks, Rocky Spur, Jan. 14, 1928, *Evans* (F).

FLORIDA: ALACHUA CO.: on red maple, low hammock, near Gainesville, Mar. 14, 1938, *Murrill* (D). COUNTY INDEFINITE: on trees, Black Forest, Sept. 1913, *Rapp* (F).

MICHIGAN: KEWEENAW CO.: Isle Royale, Aug. 12, 1901, *Stuntz & Allen* (WIS); south of lighthouse, Isle Royale, Aug. 12, 1901, *Stuntz & Allen* (WIS).

ILLINOIS: LASALLE CO.: on trees and rocks, *Calkins* (F). MENARD CO.: Athens, *Hall* (FM).

KENTUCKY: LAUREL CO.: deep wet woods 8.4 miles north of East Bernstadt, Aug. 18, 1937, *Hubricht B275* (MBG).

TENNESSEE: HAMILTON CO.: on trees, Lookout Mountain, *Calkins 285* (MIN).

MINNESOTA: COOK CO.: on young spruce trees near water, Grand Marais, July 21, 1902, *Fink 5138* (MIN); on soil-covered rocks, Grand Marais, July 21, 1902, *Fink 5133* (MIN). LAKE CO.: Baptism River, Aug. 1896, *Elfman* (WIS). ST. LOUIS CO.: on cedars in swamps, Harding, Aug. 16, 1901, *Fink 1506* (MIN). KOOCHICHING CO.: on cedars in swamps, Koochiching, July 29, 1901, *Fink 999* (MIN). BELTRAMI CO.: on tamarack in swamp, Bemidji, July 7, 1900, *Fink 621* (MIN); on old pine logs, Red Lake, July 26, 1900, *Fink 891a* (MIN); on trees in swamp, Beaudette, June 18, 1901, *Fink 29* (MIN); on cedar in swamps, Beaudette, June 22, 1901, *Fink 112* (MIN); on cedars in swamp, June 24, 1901, *Fink 129* (MIN). HUBBARD CO.: on balsam, Park Bay, Aug. 29, 1902, *Fink* (MIN). BECKER CO.: on rocks, Oak Island, July 9, 1901, *Fink 435* (MIN). OTTERTAIL CO.: on tamarack in swamp, Henning, June 25, 1900, *Fink 190* (MIN).

WISCONSIN: FOND DU LAC CO.: two miles south of Hamilton, May, 1936, *J. Thomson* (WIS). VILAS CO.: valley of the Wisconsin River, near Lac Vieux Desert, Summer 1893, *Cheney* (WIS). DANE CO.: east side of Picture Rock, Oct. 2, 1938, *Skinners* (WIS). JUNEAU CO.: north of Necedah, Apr. 1936, *J. Thomson* (WIS). SAUK CO.: on rocks, Devils Lake, Oct. 23, 1936, *J. Thomson* (WIS).

IOWA: BREMER CO.: on trees, July 1894, *Fink* (MBG).

MISSOURI: WAYNE CO.: on granite rocks, Piedmont, Mar. 1899, *C. Russell* (MBG).

ARKANSAS: CHICOT CO.: near Macon, Dec. 29, 1938, *E. Anderson* (MBG).

MONTANA: MISSOULA CO.: on granite rocks, sheltered spots, Black Bear Mountain, Bitter Root Mountains, Aug. 4, 1931, *Flint* (MONT).

WYOMING: YELLOWSTONE PARK, 1922, *Hawkins* (WIS).

COLORADO: WELD CO.: over siliceous rocks and mosses, south St. Vrain Canyon, elev. 7200 ft., Oct. 7, 1938, *Kiener* (MBG). EL PASO CO.: on moss-covered rock, elev. 8300 ft., Minnehaha, near Pikes Peak, July 1919, *I. M. Johnston* (F); on dead spruce, Palmer Lake, July 9, 1928, *Laedig* (F).

NEW MEXICO: RIO ARRIBA CO.: northward face of cliff, vicinity of Brazos Canyon, Sept. 4, 1914, *Standley & Bollman* (US).

ALASKA: logs in Cross Sound, June 18, 1880, *Bean* (FM); Unalaska, July 28, 1882, *Bean* (FM); on *Picea*, near Kink, Aug. 1913, *Cheney 159* (MBG); on bark of trees, Quinhagak, Nov. 19, 1921, *Stecker* (FM); at Cape Lisbon, Arctic Ocean, *Bean* (FM).

BRITISH COLUMBIA: on trees and old fences, Comox and Victoria, Vancouver Island, May 1893, *Macoun 150* (MIN,MBG); on boulders, Sidney, Vancouver Island, Sept. 26, 1913, *Macoun* (F); Vancouver Island, Oregon Boundary Commission, 1858–59, *Lyall* (F); New Westminster, Jan. 1903, *Macoun* (F).

WASHINGTON: WHITMAN CO.: on thin soil, Pullman, Feb. 22, 1901, *Cotton* (F). SPOKANE CO.: on granitic rocks, Spokane, Dec. 29, 1906, *Bonser* (F). KLICKITAT CO.: north face of boulder, Little Klickitat Bluffs, Goldendale, Oct. 24, 1909, *Foster* (F). ISLAND CO.: on rock, Langley, June 1923, *Grant* (D); on trees, Montesano, June 1919, *Grant* (F). CHEHALIS CO.: near Aberdeen, Apr. 4, 1909, *Foster* (D).

CALIFORNIA: NAPA CO.: on oak trees 1 mile south of Pope Valley Post-office, July 9, 1938, *Ownbey & Ownbey* (MBG). SHASTA CO.: on bark of tree, region of upper Sacramento, July 24–Aug. 10, 1894, *Howe* (US). SAN MATEO CO.: on sand-

stone hills 4 miles west of Stanford University, elev. 300 ft., July 22, 1903, *Herre 172* (MIN,MBG); on sandstone, Pilarcitos Creek, elev. 200 ft., 2 miles from Pacific Ocean, June 30, 1906, *Herre 830* (MIN,F). COUNTY UNKNOWN: on sandstone rocks, Searsville Ridge, elev. 500 ft., July 22, 1903, *Herre* (F).

LOCAL AND FOREIGN EXSICCATAE EXAMINED: Bohl. *11;* Claud. *173;* Cromb. *27;* Cum. I *352;* Cum. II *274;* Desm. ed. I. ser. I *1940,* ed. II. ser. I *1590;* Elenk. *53 a–c;* Erb. I *118;* Fellm. *77;* E. Fries *168;* Funck, II *108;* Hav. *179, 223;* Larb. Herb. *211;* Leight. *203;* Malme, *265;* Moug. & Nest. *249;* Oliv. *116;* R. & S. *35;* Rab. Cent. *16;* Salw. *140;* Stenh. *155 (saxicola), 156 (corticola);* Trev. *267.*

21a. Parmelia saxatilis var. **Anzi** Del. apud Duby, Bot. Gallic. **2**: 602. 1830.

Parmelia horrescens Tayl. apud Mack., Fl. Hibern. **2**: 144. 1836.

Delise's type was from France and is in his herbarium. Taylor's type of *P. horrescens* was from County Kerry, Ireland, and is in his herbarium at the Boston Society of Natural History in Boston.

Thallus grayish-white, densely clothed with grayish-brown isidioid excrescences, otherwise as in the species; K, upper cortex and medulla yellow, medulla becoming red-brown; C, upper cortex and medulla yellow, K + C, yellow, P, red-brown.

The distribution of the variety is limited to the northern part of United States and southern Canada. It is found on wet or shaded rocks.

Distribution: Newfoundland to Maine, west to British Columbia.

NEWFOUNDLAND: on rock, Western Cove, Nov. 12, 1881, *Waghorne* (MIN); on rocks, "Plane Sallon," July 23, 1893, *Waghorne 11* (MIN); on rocks, Red Bay, Aug. 12, 1899, *Waghorne 43* (MIN); Chance Cove, Trinity Bay, Sept. 11, 1892, *Waghorne* (MIN).

QUEBEC: GASPÉ CO.: wet rocks and chimneys, elev. 825–1125 m., Rivière Ste. Anne des Monts, Tabletop Mountains, Aug. 5, 1923, *Fernald, Dodge & Smith* (D).

MAINE: HANCOCK CO.: Salisbury Cove, Aug. 29, 1931, *Plitt* (BPI). KNOX CO.: on granite, South Thomaston, Sept. 17, 1910, *Merrill* (MIN).

NEW HAMPSHIRE: COOS CO.: alpine regions, White Mountains, 1863, *Mann* (FM).

MINNESOTA: YELLOW MEDICINE CO.: Granite Falls, July 17, 1899, *Fink 561* (MIN). CLAY CO.: on rocks in shaded places near Ulen, July 5, 1899, *Fink 268* (MIN).

BRITISH COLUMBIA: Oregon Boundary Commission, Vancouver Island, 1858–59, *Lyall* (WIS).

22. Parmelia sulcata Taylor apud Mack., Fl. Hibern. 2: 145. 1836.

Taylor's type was from County Kerry, Ireland, and is in his herbarium in the Boston Society of Natural History at Boston.

Thallus loosely adnate, 5–12 cm. diameter; upper surface with reticulate ridges of white soredia, light greenish-gray or light brown, lobes short, wide, rounded, imbricated, dichotomously branched; lower surface black to the margin, with strong black rhizinae to margin of thallus; lower cortex unbroken; apothecium sessile, 1–15 mm. diameter, margin unfissured but slightly sorediate; K, upper cortex yellow, medulla yellowish-brown; C, upper cortex yellow, medulla none; K + C, yellow; P, red-brown.

Algal layer continuous, 20–24 μ thick; upper cortex 20–28 μ thick; medulla of loosely interwoven hyphae of one type, hyaline and of small diameter; lower cortex 16–32 μ thick; thallus 120–160 μ thick; thecium 64–80 μ thick; ascus clavate, spores 8, 4–5 × 12–14 μ; paraphyses branched.

Distribution: Newfoundland to Tennessee, west to Washington and California.

NEWFOUNDLAND: on rocks, July 7, 1893, *Waghorne* (MBG,MIN); on rocks, Outer Cove, Dec. 11, 1891, *Waghorne* (W).

NOVA SCOTIA: on old boards, rails and trunks, Sable Island, July 27, 1899, *Macoun* (MBG).

MAINE: WASHINGTON CO.: July 1929, *Markin* (WIS). KENNEBEC CO.: on rock maple, Albion, Mar. 23, 1922, *Parlin 5* (D). CUMBERLAND CO.: on tree trunks and stones, Nov. 7, 1855, *Blake* (FM).

NEW HAMPSHIRE: COUNTY INDEFINITE: summit of Mount Willard, June 2, 1882, *Faxon* (WIS).

VERMONT: WINDSOR CO.: on ledges, Mount Horrid, Rochester, elev. 2700 ft., Oct. 3, 1920, *Dutton 1110* (WIS). ADDISON CO.: on *Acer rubrum*, college campus, Middlebury, Apr. 12, 1913, *Dodge 160* (D). RUTLAND CO.: on cedar in swamp, Brandon, elev. 475 ft., Feb. 26, 1921, *Dutton 1217* (WIS,FM); Chipman Lake, Tinmouth, June 1938, *Dodge* (D).

MASSACHUSETTS: ESSEX CO.: on rocks, Rockport, Apr. 7, 1899, *Cummings 325* (WIS). MIDDLESEX CO.: Concord, 1863, *Mann* (FM).

OHIO: CLARK CO.: Springfield, 1879, *Mrs. E. J. Spence* (F).

MICHIGAN: KEWEENAW CO.: Isle Royale, Sept. 9, 1901, *Stuntz & Allen* (WIS).

TENNESSEE: COUNTY UNKNOWN: on rocks, *Calkins 344* (FM).

WISCONSIN: ADAMS CO.: bluffs 10 miles east of Friendship, Oct. 13, 1935, *J. Thomson* (WIS). MONROE CO.: 9 miles west of Tomah, Nov. 14, 1935, *J. Thomson*

(WIS). RICHLAND CO.: valley of the Wisconsin River near Eagle River, June 27, 1893, *Cheney 870* (WIS).

ILLINOIS: LASALLE CO.: on rocks, *Calkins* (FM). COOK CO.: on trees, *Calkins* (FM).

MINNESOTA: ST. LOUIS CO.: on rocks, Tower, Aug. 23, 1901, *Fink 1710* (MIN). CARLTON CO.: on rocks, Kettle Falls, Aug. 12, 1901, *Fink 1380* (MIN). KOOCHICHING CO.: Gunflint, June 30, 1897, *Fink 240* (MIN); on old stump, Battle Lake, June 22, 1900, *Fink 134* (MIN); on rocks, Rainy Lake, Aug. 1, 1901, *Fink 1083* (MIN); on trees, Koochiching, July 25, 1901, *Fink 886* (MIN). BLUE EARTH CO.: on old log, Mankato, June 28, 1899, *Fink 165* (MIN). LAKE OF THE WOODS CO.: on old wood, Lake of the Woods, July 1896, *Millan 3* (MIN). BELTRAMI CO.: on trees, Red Lake, Aug. 2, 1900, *Fink 1049* (MIN); on dead pine logs, Bemidji, July 4, 1900, *Fink 423* (MIN); on oaks, Bemidji, July 4, 1900, *Fink 447* (MIN); on tamarack, in swamp, Bemidji, July 7, 1900, *Fink 525* (MIN); on rocks along Red Lake, Aug. 1, 1900, *Fink 1038* (MIN). YELLOW MEDICINE CO.: on shaded rocks, Granite Falls, July 17, 1899, *Fink 586* (MIN). ROSEAU CO.: on trees, Warroad, June 25, 1901, *Fink 170* (MIN). MARSHALL CO.: on old logs, Thief River, July 19, 1900, *Fink 813* (MIN). ROCK CO.: on Mound Creek, Sept. 1901, *Wheeler* (MIN). COUNTY UNKNOWN: on trees, Flag Island, July 12, 1901, *Fink 536* (MIN); on bark, Flag Island, Aug. 1897, *Millan & Sheldon* (MIN); on dead pine, 1900, *Fink* (F).

IOWA: BREMER CO.: on trees, July 1894, *Fink* (MIN).

SOUTH DAKOTA: MEAD CO.: Piedmont, 1892, *Pratt* (F).

MONTANA: LEWIS AND CLARK CO.: on forest duff and humus, sect. 7–8 T. 12 W. R. 9W., Helena Forest, *Flint* (MONT). MISSOULA CO.: Mitten Mountain, near Missoula, elev. 4000 ft., Dec. 1930, *Flint* (MONT); Pattee Canyon, close to slaughterhouse, Jan. 15, 1934, *Flint* (MONT); on alder stem, Pattee Canyon, near Missoula, elev. 3500 ft., May 1, 1935, *Flint* (MONT); on granite rocks, sheltered spots, Black Bear Mountain, Bitterroot Mountains, Aug. 14, 1931, *Flint* (MONT).

WYOMING: CROOK CO.: Sundance Mountain, July 3, 1896, *A. Nelson* (MBG); Hayden Expedition, 1872, *J. M. Coulter* (US).

COLORADO: WELD CO.: over siliceous rocks and mosses, south St. Vrain Canyon, elev. 7200 ft., Oct. 7, 1936, *Kiener* (MBG).

NEW MEXICO: COLFAX CO.: moist bank, vicinity of Ute Park, Aug. 29, 1916, *Standley* (F).

IDAHO: NEZ PERCE CO.: elev. 1000 ft., Apr. 30, 1896, *Heller & Heller* (MBG, MIN).

BRITISH COLUMBIA: on the old wharf, Comox, Vancouver Island, June 24, 1893, *Macoun* (MBG,US); on trees and old fences, Victoria, May 1893, *Macoun* (F).

WASHINGTON: ISLAND CO.: on rocks, Langley, May 1920, *Grant* (WIS); on log, Langley, 1923, *Grant* (WIS); on *Tsuga* log, Oct. 1922, Langley, *Grant* (WIS); on limbs of trees, Langley, 1921, *Grant 232* (F). SAN JUAN CO.: San Juan, July 27, 1906, *Fink* (FM).

OREGON: MULTNOMAH CO.: on bark of maple, Portland, Apr. 29, 1906, *Foster* (F).

CALIFORNIA: SANTA CRUZ CO.: on sandstone, Devil's Canyon, elev. 2300 ft., July 28, 1905, *Herre 702* (MIN).

FOREIGN AND LOCAL EXSICCATAE EXAMINED: Claud. *17*; Elenk. *106a, b*; Harm. Lich. Loth. *297*; Hav. *180*; Johns. *69*; Malme *230*; Merr. *27*; Mudd, *66*; Salw. *168*.

23. Parmelia Herrei Zahlbr. apud Herre, Proc. Wash. Acad. Sci. **7**: 353. 1903.

The type was collected on earth and sandstone, Pilarcitos Creek Canyon, 2 miles from the ocean, in San Mateo County, California, by A. C. Herre, and is now in the United States National Herbarium.

Thallus gray to yellowish-gray in herbarium material, lobes long, narrow, tips rounded or wavy, somewhat sorediate, center of thallus becoming imbricate with the tangling of the lobes, margin fringed with long black cilia, below densely covered with long black rhizinae; apothecia not known; K, none, C, brown, K + C, none, P, none.

Algal layer continuous, 15–18 μ thick, upper cortex 34–38 μ thick, matrix light-colored; medulla loosely interwoven; lower cortex 18–26 μ thick, matrix black; thallus 66–90 μ thick.

The plant resembles *P. saxatilis* but is more rugged in appearance. It has been collected only from the type locality and by A. C. Herre.

Distribution: Plant unknown except in type locality.

CALIFORNIA: SAN MATEO CO.: on earth and sandstone, Pilarcitos Creek Canyon, 2 miles from the ocean, elev. 200 ft., May 28, 1904, *Herre* (Type collection) (US); on earth and sandstone, Pilarcitos Creek Canyon, 2 miles from the ocean, elev. 200 ft., June 30, 1906, *Herre* (MBG,F,MIN,LSU,M).

24. Parmelia Borreri Turn. apud Sm. & Sowerb., Eng. Bot. **25**: *tab. 1780.* 1807.

Lichen Borreri Sm. apud Sm. & Sowerb., Eng. Bot. **25**: *tab. 1780.* 1807.

Parmelia Borreri var. *hypomela* Tuck., Syn. N. Amer. Lich. **1**: 58. 1882.

The plants used as types by both Turner and Smith are unknown, though their material came from Sussex, England. The plates cited by Smith in Smith and Sowerby's 'English Bottany' **25**: *t. 1780.* 1807, and Turner, 'Transactions Linnean Society London' **9**: *tab. 13, f. 2.* 1808, are well made and represent the descriptions of the plants. Tuckerman's type of the variety is a collection made in Illinois and is in his herbarium at the Farlow.

Thallus light grayish-green to olive-green, adnate, wrinkled,

margins of lobes round and usually wavy, from which short flat dichotomously branched sorediate lobules arise, surface of thallus glaucous, black ostioles of the spermagonia prominent on the younger portions of the upper surface; lower surface, dirty white to dark brown, with numerous white or darkening rhizinae; apothecia numerous, sessile or short-pedicellate, 0.5–14 mm. diameter, disks deeply to slightly concave, chestnut-brown to dark brown, margins regular with vertical grooves marking the outside of the amphithecia, occasionally sorediate; K, upper cortex yellow, medulla none; C, medulla red; K + C, none; P, none.

Algal layer continuous, 20–31 μ thick; upper cortex 20–24 μ thick; medullary hyphae loosely interwoven, hyaline; lower cortex 20–30 μ thick; ascus clavate, spores 8, 8–10 × 10–12 μ; thecium 60–96 μ thick; thallus 400–600 μ thick.

Distribution: Vermont to North Carolina, west to British Columbia and California.

ONTARIO: on trunks, Algonquin Park, May 27, 1900, *Macoun 241* (MBG,US).

VERMONT: ADDISON CO.: on *Abies canadensis*, Monkton, Dec. 2, 1878, *Faxon* (MBG).

MASSACHUSETTS: MIDDLESEX CO.: Blue Hills, Nov. 6, 1883, *Faxon* (WIS). NORFOLK CO.: Weymouth, *Willey* (BSNH).

NORTH CAROLINA: BUNCOMBE CO.: on trees, Asheville, Feb. 1899, *C. Russell* (M).

MICHIGAN: EMMET CO.: Harbor Springs, Sept. 1931, *Mains* (M).

INDIANA: UNION CO.: on bark, July 25, 1917, *Fink & Funston 75* (F).

WISCONSIN: BURNETT CO.: valley of the Wisconsin River near Webster, summer 1894, *Cheney* (WIS). ONEIDA CO.: Aug. 27, 1936, *Peck* (MBG). GREEN LAKE CO.: on shagbark hickory, above granite outcrop, 2 miles south of Marquette, Sept. 4, *Shinners* (WIS).

ILLINOIS: COOK CO.: on oaks, *Calkins* (NYBG); River Forest, June 22, 1893, *Harper & Harper* (FM); on bark of trees, Palos Park, May 30, 1900, *Harper & Harper 99* (FM). CHAMPAIGN CO.: on oak trunks, Urbana, Feb. 8, 1879, *Earle* (NYBG). LASALLE CO.: on oaks, *Calkins 2* (F). MENARD CO.: on old fences, Athens, *Hall* (FM); Athens, 1878, *Hall* (Type of Tuckerman's variety) (MBG).

KENTUCKY: MADISON CO.: glade, 10 miles north of Richmond, Aug. 18, 1937, *Hubricht B199* (MBG).

MINNESOTA: HENNEPIN CO.: on bark, Lake Harriet, Apr. 1890, *Frost* (MIN). BLUE EARTH CO.: on trees, Mankato, June 22, 1899, *Fink 11* (MIN). BELTRAMI CO.: on trees, Red Lake, July 26, 1900, *Fink 893* (MIN); on pines, Bemidji, July 11, 1901, *Fink 658* (MIN). MEEKER CO.: on bark, Litchfield, June 1892, *Frost F46* (MIN). REDWOOD CO.: on rocks, Redwood Falls, July 8, 1899, *Fink 335* (MIN). OTTERTAIL CO.: on trees, Leaf Hills, June 27, 1900, *Fink 281* (MIN); on trees, Battle Lake, June 20, 1900, *Fink 43* (MIN). PENNINGTON CO.: on trees, Thief River Falls, July 19, 1900, *Fink 824* (MIN); Red River, May 1856, *Lapham* (WIS).

IOWA: CLAYTON CO.: on trees, Apr. 1894, *Fink* (WIS); on trees, Sept. 1894, *Fink* (MBG). JOHNSON CO.: Iowa City, 1885, *Macbride* (IA); on *Quercus alba*, March 13, 1896, *Fitzpatrick & Fitzpatrick* (FM). FAYETTE CO.: on trees, Sept. 20, 1892, *Fink* (MBG).

MISSOURI: ST. LOUIS CO.: bark of tree, Allenton, May 5, 1938, *Berry* (MBG); bark of tree, 2 miles southeast of Centaur Station, Jan. 1, 1937, *Hubricht 817* (MBG). IRON CO.: on granite rocks, Buford Mountain, Nov. 1897, *C. Russell 4* (MBG). BOONE CO.: bark of tree, Sept. 17, 1930, *Berry* (MO,MBG). MORGAN CO.: bark of hickory tree, Oct. 25, 1930, *Berry* (MO,MBG). SALINE CO.: fence rails, Emma, 1892, *Demetrio* (MBG). JOHNSON CO.: bark of tree, Warrensburg, Jan. 3, 1938, *Berry* (MBG).

NORTH DAKOTA: CASS CO.: on trees, Fargo, June 1914, *Brenckle 1015* (F).

SOUTH DAKOTA: BROOKINGS CO.: trees and dead wood, Brookings, June 13, 1891, *Luke* (MBG); on elm trees, Brookings, Apr. 1895, *Williams 155* (MBG,WIS, MIN,FM).

TEXAS: GILLESPIE CO.: *Jermy* (MBG). LIMESTONE CO.: Grossbeck Mountain, summer 1931, *Jones & Hedrick* (M); *C. Wright*, 1848–50 (T). REAL CO.: shade, Frio Canyon, 11 miles north of Leakey, May 23, 1938, *Hubricht B777* (MBG). DENTON CO.: in group of "*Quercina minor*," 3 miles southwest of Denton, Feb. 1935, *Bussard V* (MBG).

BRITISH COLUMBIA: on old wharf, Comox, June 24, 1893, *Macoun 149* (MBG).

CALIFORNIA: SANTA CRUZ CO.: on oaks, Ano Nuevo Creek, Santa Cruz Mountains, Aug. 9, 1906, *Herre* (MBG,LSU).

LOCAL AND FOREIGN EXSICCATAE EXAMINED: Malbr. Lich. Nor. *269;* Harm. Lich. Loth. *294;* Flag. Lich. Fr.-C. *73;* Mus. Krypt. Exs. Vind. *3163;* Moug. & Nest. *634;* Cum. Lich. Bor. Am. *85, 165.*

The citation of *Parmelia dubia* by Schaerer as a synonym of *Parmelia Borreri* was evidently based on a typographical error. *Lichen dubius* Wulf. apud Jacq. (Collectanea **4**: 275, *t. 19, f. 1.* 1790) has powdery soredia on the margins and clearly is not the plant described as *P. Borreri* by Turner.

25. Parmelia Bolliana Müll.-Arg., Flora **60**: 78. 1877.

The type was collected by J. Boll in Van Zandt County, Texas, and sent to Müller-Argau for determination. It is now in the Herbier Boissier, Université de Genève, Switzerland.

Thallus greenish-brown, much wrinkled, with reticulate secondary ridges, many little white dots where the upper cortex has been lost and the white medulla is exposed, lobes short and round, margins smooth; under surface white at the margin, becoming light brown beneath, with thinly scattered, small, light brown rhizinae; apothecia numerous, 1–2 mm. diameter, sessile, deeply concave to almost flat, disks chestnut-brown; amphithe-

cium marked with deep vertical lines or ridges; K, none, C, none, K + C, pink, P, none.

Algal layer continuous, 20–25 μ thick; upper cortex 20–22 μ thick; medulla loosely interwoven, diameter of hyphae 1.1–2 μ; lower cortex 20–25 μ thick, matrix light-colored; thallus 400–570 μ thick; ascus clavate, spores 8, 7–9 × 12–14 μ; paraphyses branched.

Distribution: Missouri, Texas, and Arkansas.

MISSOURI: WAYNE CO.: on trees, Clark Mountain, Nov. 1, 1898, *C. Russell* (MBG). ARKANSAS: BOONE CO.: rocky wooded bluff, above dry creek bed, Bear Creek Spring, 0.5 mile north of Francis, Apr. 7, 1939, *Dodge, Berry & Johnson* (MBG). TEXAS: VAN ZANDT CO.: on trees, *J. Boll* (Co-type) (T). GILLESPIE CO.: *Jermy* (MBG). BREWSTER CO.: full sun to semi-shade, 18 miles south of Marathon, May 27, 1938, *Hubricht B853* (MBG). CULBERSON CO.: full sun to semi-shade, north side of summit, Van Horn Mountains, 15 miles south of Van Horn, June 2, 1938, *Hubricht B946* (MBG).

26. Parmelia quercina (Willd.) Wainio, Termeszetr. Fuzetek **22**: 279. 1899.

Lichen quercinus Willd., Fl. Berol. Prodr. 353. 1787; Ach., Lich. Suec. Prodr. 124. 1798.

Lichen tiliaceus Hoffm., Enum. Lich. 97. 1784.

Parmelia tiliacea Ach., Meth. Lich. 215. 1803, not *Lobaria tiliacea* Hoffm.

Imbricaria quercina DC. apud Lam. & DC., Fl. Fr. ed. 3, **2**: 390. 1815.

Willdenow used *Lichen quercinus* to designate this lichen in 'Florae Berolinensis Prodromus,' 353. 1787. Hoffmann, in his 'Deutschlands Flora' **2**: 149. 1795, designates it *Lobaria tiliacea* and cites his 'Enumeratio Lichenum,' *t. 16, f. 2.* 1784, where the epithet *Lichen tiliaceus* was used. Hoffmann cites Willdenow and considers *Lichen quercinus* as synonymous with *Lobaria tiliacea.* Acharius (Lichenographiae Suecicae Prodromus, 124. 1798) uses the epithet *Lichen quercinus* of Willdenow, considering Hoffmann's *Lichen tiliaceus* as belonging to another plant. He questioned the identity of *Lobaria tiliacea* given by Hoffmann (Deutschl. Fl. **2**: 149. 1795) as a synonym of *Lichen quercinus* Ach. (Lich. Suec. Prodrom. 124. 1798). In his 'Meth. Lich.' 215. 1803, Acharius applied the epithet *Parmelia tiliacea,* citing *Lichen quercinus* Willd. (Fl.

Berol. Prodr. 353. 1787), but considering the figure and description in Hoffmann's 'Enum. Lich.' 1784, as that of *Lichen scorteus*. This would make Willdenow's 'Florae Berolinensis Prodromus,' 353. 1787, the oldest valid description of the plant, and his name, *quercinus*, should be used. Willdenow's collections were from the vicinity of Berlin, and his type is in Berlin. Acharius' herbarium, at Helsinki, contains collections of the species which he determined. Except for the plates, there seems to be none of Hoffmann's material left. DeCandolle (Fl. Fr. ed. 3, **2**: 390. 1815) cites *Lichen quercinus* (Willd., Fl. Berol. Prodr. *t. 7, f. 13.* 1787; and Ach., Lich. Suec. Prodr. 124. 1798) as synonymous with his plant. DeCandolle's specimens are in Genève, Switzerland.

Thallus 5–15 cm. diameter, closely adnate, usually wrinkled at the center, greenish-gray, lobes short and round, occasionally elongated and subdichotomously branched, margins irregular, crenate; apothecium sessile, 4–12 mm. diameter, disk slightly to deeply concave, light chestnut-brown; amphithecium entire or dissected; K, upper cortex yellowish-green, medulla greenish; C, none, K + C, none, P, yellow.

Algal layer continuous, 48–52 μ thick; upper cortex 10–16 μ thick, matrix yellow-brown; medulla loosely interwoven, hyphae hyaline and of small diameter; lower cortex 40–44 μ thick, matrix black; thallus 288–300 μ thick; thecium 24–28 μ thick; ascus clavate, spores 8, 4–5 × 6–8 μ; paraphyses branched, enlarged at tips.

Distribution: New Brunswick to Florida, west to Wyoming and California.

NEW BRUNSWICK: on trees, *Willey* (BSNH).

ONTARIO: on tree trunks in wood, Ottawa, May 2, 1900, *Macoun* (MBG); on tree trunks, Ottawa, June 24, 1898, *Macoun* (MBG); on trees, Emo, July 18, 1901, *Fink 693* (MIN).

MAINE: WASHINGTON CO.: June 1929, *Markin* (WIS). AROOSTOOK CO.: St. Francis, Aug. 1893, *Cummings 102* (MIN). PISCATAQUIS CO.: on high river bluffs with red maple, poplar, and balsam, Camp Sunday, Medford Township, Aug. 28, 1905, *Merrill* (NYBG). KNOX CO.: on various trees, Warren, Apr. 30, 1911, *Merrill 221* (MIN).

NEW HAMPSHIRE: COOS CO.: Shelburne, Aug. 1894, *Farlow* (FM); on pine trees, base of Mount Washington, Aug. 6, 1895, *Harper & Harper* (FM).

VERMONT: ADDISON CO.: on dead wood, Middlebury, Apr. 22, 1913, *Dodge* (D).

RUTLAND CO.: on maple tree, Pawlet, Mar. 22, 1913, *Dodge* (D); Chipman Lake, Tinmouth, June 1938, *Dodge* (D).

MASSACHUSETTS: NORFOLK CO.: Hazelwood, Mar. 20, 1882, *Faxon* (WIS). BRISTOL CO.: stones in wall, New Bedford, 1878, *Willey* (US); bark of trees, New Bedford, *Willey* (MIN,MBG); New Bedford, 1862–1898, *Willey* (US); trunks, New Bedford, *Willey 32* (FM). COUNTY INDEFINITE: New England Lichens, *Wright* (MBG).

NEW YORK: QUEENS CO.: on *Acer*, East Port, Long Island, June 26, 1894, *Schrenk* (US). YATES CO.: Penn Yan, *Buckley* (MBG); Dundee, *S. Wright 40* (FM).

PENNSYLVANIA: MIFFLIN CO.: Sept. 1879, *Rothrock* (FM). CHESTER CO.: June 27, 1879, *Rothrock & Rothrock* (FM).

MARYLAND: MONTGOMERY CO.: rock outcrop, cliffs near Cabin Hill, Plummers Island, Potomac River, near Cabin John, Nov. 6, 1938, *Leonard 2821* (US); base of oaks, West Knob, Plummers Island, Potomac River, near Cabin John, Nov. 6, 1938, *Leonard 2775* (US); rock outcrop, West Knob, Plummers Island, Potomac River, near Cabin John, Nov. 6, 1938, *Leonard 2764* (US).

VIRGINIA: PRINCE WILLIAM CO.: on old walnut logs near ruins of old house, between High Point Ridge and ridge east, Bull Run Mountain, June 23, 1937, *Allard 77632* (US). LEE CO.: edge of woods, Hunter's Gap, Powell Mountain, 2.7 miles north of Blackwater, Aug. 23, 1937, *Hubricht B412* (MBG).

NORTH CAROLINA: HENDERSON CO.: bark of tree, Flat Rock, July 4, 1921, *Schallert 2026* (FM); base of tree, Grandfather Mountain, June 13, 1936, *Schallert* (MBG).

GEORGIA: THOMAS CO.: Thomasville, 1906, *Mrs. A. P. Taylor* (F).

FLORIDA: ORANGE CO.: on living cypress in swamp, Sanford, July 1906, *Rapp 17* (F). LEON CO.: Tallahassee, Nov. 1891, *Farlow* (F). COUNTY UNKNOWN: *Calkins 4* (MBG); Upsala, Nov. 1921, *Rapp 663* (F).

ALABAMA: MOBILE CO.: Mobile, *Mohr* (US). MARSHALL CO.: open woods, 3 miles north of Boaz, July 21, 1939, *Hubricht B1543* (MBG).

OHIO: ATHENS CO.: on oak, Sept. 22, 1938, *Wolfe 257* (O). PERRY CO.: on tree, Apr. 4, 1936, *Wolfe 546* (O). VINTON CO.: on maple, Mar. 14, 1936, *Wolfe 513* (O). PICKAWAY CO.: on locust, Apr. 19, 1936, *Wolfe 631* (O). PIKE CO.: on linden, Sept. 15, 1935, *Wolfe* (NYBG); on linden, Sept. 15, 1935, *Wolfe 215* (O). JACKSON CO.: on dead branch, Nov. 3, 1935, *Wolfe 335* (O). CLERMONT CO.: on bark, Apr. 18, 1936, *Wolfe & Hill 610* (O). COUNTY UNKNOWN: on a poke tree, Apr. 12, 1918, *Fink* (D).

MICHIGAN: COUNTY UNKNOWN: on trees, Sailors Encampment, Aug. 3, 1897, *Harper & Harper 55* (FM).

KENTUCKY: LAUREL CO.: deep wet woods, 8.4 miles north of East Bernstadt, Aug. 18, 1937, *Hubricht B280* (MBG). KNOX CO.: 1.4 miles north of Jarvis Store, Aug. 19, 1937, *Hubricht B316* (MBG).

TENNESSEE: HAMILTON CO.: on elms, Chattanooga, *Calkins 4* (FM); on trees, Missionary Ridge, *Calkins 1* (MIN). SEVIER CO.: woods, elev. 3600 ft., "The Loop," 10 miles south of Gatlinburg, Aug. 25, 1937, *Hubricht B518* (MBG).

WISCONSIN: VILAS CO.: valley of the Wisconsin River, near Lac Vieux Desert, Summer 1893, *Cheney 41* (WIS). PORTAGE CO.: valley of the Wisconsin River, near Stevens Point, Summer 1894, *Cheney 3498* (WIS). TAYLOR CO.: valley of the Wisconsin River near Goodrich, Summer 1894, *Cheney* (WIS).

ILLINOIS: LAKE CO.: on oak, Lake Bluff, May 1906, *Harper & Harper 100* (FM). LASALLE CO.: on trees, *Calkins* (F,FM). MENARD CO.: on trees, 1878, *Hall* (FM); Athens, 1878, *Hall* (MIN,MBG,WIS).

MINNESOTA: COOK CO.: on cedar, Grand Marais, Aug. 22, 1902, *Fink 156* (MIN). LAKE CO.: on trees, Beaver Bay, July 14, 1897, *Fink 724* (MIN); on trees, Snowbank Lake area, July 23, 1897, *Fink 896* (MIN). ST. LOUIS CO.: on bark of *Fraxinus*, Vermillion Lake, July 19, 1886, *Bailey & Holway A226* (MIN); on trees, Ely, July 28, 1897, *Fink 1018* (MIN); on trees, Harding, Aug. 17, 1901, *Fink 1560* (MIN); on trees, Tower, Aug. 23, 1901, *Fink 1698* (MIN). CARLTON CO.: on trees, Kettle Falls, Aug. 13, 1901, *Fink 1417* (MIN); on trees, Tafte, Carlton Peak, July 10, 1897, *Fink 620* (MIN). KOOCHICHING CO.: on trees, Koochiching, July 26, 1901, *Fink 922* (MIN); on trees, Gunflint, July 2, 1897, *Fink 407* (MIN). AITKIN CO.: on *Pinus Strobus*, Mille Lacs Indian Reservation, June 1892, *Sheldon S2328* (MIN); on *Quercus macrocarpa*, Mille Lacs Lake, June 1, 1892, *Sheldon S2289* (MIN). CROW WING CO.: on *Quercus tinctoria*, Garrison, June 1892, *Sheldon S2236* (MIN). BLUE EARTH CO.: on trees, Mankato, June 23, 1899, *Fink 56* (MIN). BELTRAMI CO.: on oaks, Bemidji, July 4, 1900, *Fink 449* (MIN); on trees, Red Lake, July 31, 1900, *Fink 1003* (MIN); on balsam in swamp, Beaudette, June 18, 1901, *Fink 9* (MIN). MARSHALL CO.: on trees, Thief River Falls, July 23, 1900, *Fink 874* (MIN). OTTERTAIL CO.: on trees, Leaf Hills, June 26, 1900, *Fink 208* (MIN); on trees, Battle Lake, June 18, 1900, *Fink 16* (MIN).

IOWA: JOHNSON CO.: on bark, Jan. 8, 1898, *Fink & Savage* (IA). HENRY CO.: on bark, Jan. 1898, *Savage* (IA). BREMER CO.: on trees, Aug. 29, 1895, *Fink* (D). FAYETTE CO.: on trees, Sept. 1892, *Fink* (MBG,WIS).

MISSOURI: ST. LOUIS CO.: Cliff Cave, Aug. 26, 1899, *Norton* (US); on *Crataegus tomentum*, covering the branches, Crescent, May 1896, *C. Russell* (MBG); bark of oak tree, Ranken Estate, Nov. 20, 1936, *Berry* (MBG). ST. FRANCOIS CO.: on bark of trees, Pickle Springs, May 21, 1938, *Berry* (MBG). WAYNE CO.: on oak trees, Clark Mountain, Mar. 16, 1892, *C. Russell* (US). BUTLER CO.: on bark of *Ostrya*, Neelyville, Dec. 25, 1898, *C. Russell* (MBG).

ARKANSAS: BAXTER CO.: dry upland woods, 1 mile west of Big Flat, Apr. 9, 1939, *Dodge, Berry & Johnson* (MBG). SEARCY CO.: open wooded hillside, 4 miles west of Marshall, Apr. 9, 1939, *Dodge, Berry & Johnson* (MBG). BOONE CO.: rocky wooded bluff above dry creek bed, Bear Creek Spring, 0.5 mile north of Francis, Apr. 7, 1939, *Dodge, Berry & Johnson* (MBG). NEWTON CO.: steep dry wooded bluff with rocky flat top, 1 mile south of Ponca, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG); moist woods on gentle slope near Marble Falls, 11 miles south of Harrison, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG). GARLAND CO.: on dead oak tree, Carpenters Road, Hot Springs, June 30, 1939, *Scully 1342* (MBG); on dead branches, North Mountain, Hot Springs, Dec. 15, 1939, *Scully 1407* (MBG).

TEXAS: GALVESTON CO.: Galveston, *Hall 362* (FM).

WYOMING: CROOK CO.: Sundance Mountain, July 3, 1896, *A. Nelson* (MBG).

CALIFORNIA: SANTA CLARA CO.: trees and shrubs, summit of Black Mountain, elev. 2785 ft., July 6, 1903, *Herre* (US). RIVERSIDE CO.: on oak, San Jacinto Mountains, elev. 1600 m., 1903, *Hasse 187* (MIN).

FOREIGN AND LOCAL EXSICCATAE EXAMINED: Claud. *506;* Cum. I, *23, 102,* II, *23;* Elenk. *5;* Erb. I, *465;* Flag. Alg. *11;* E. Fries, *169;* Funck, I, *141;* Lojk. Univ. *62;* Stenh. *154; P. quercina* var. *scortea* Claud. *117;* Erb. I *931;* Flag. Lich. Fr.-C. *72;* Tuck. III & IV, *70; P. quercina* var. *sublaevigata* Bal. *4176, 4210;* Spruce, *136, 156; P. quercina* var. *vicinior* Merr. *221.*

27. Parmelia texana Tuck., Am. Jour. Arts & Sci. II. **25**: 424. 1858.

Tuckerman's type was based on *Charles Wright 228*, from Blanco, Texas. The type is now in the Tuckerman Herbarium.

Thallus light greenish-gray, wrinkled and covered with many small powdery soredia, margins of lobes round and irregular; lower surface black, margins lighter, with papillose rhizinae toward the center; apothecium sessile, 1–6 mm. diameter, disk concave, chestnut-brown, amphithecium thick, wavy, and more or less sorediate; K, none, C, none, K + C, brown, P, none.

Algal layer discontinuous, groups of algae 40–42 μ in diameter; thickness of upper cortex 20–21 μ, of lower cortex 20–21 μ; medulla of loosely interwoven hyaline hyphae; thallus 700–712 μ thick; thecium 88–90 μ thick, ascus clavate, spores 8, 2–4 × 7–12 μ; paraphyses unbranched and slightly inflated at the tips.

Distribution: South Carolina to Florida, west to Oklahoma and Texas.

SOUTH CAROLINA: COUNTY UNKNOWN: *Curtis* (NYBG).
GEORGIA: THOMAS CO.: Thomasville, Aug. 1906, *Taylor* (F).
FLORIDA: ORANGE CO.: on oak trunks, Sanford, Nov. 1906, *Rapp 19* (F); on *Sabal Palmetto*, Mar. 7, 1910, *Rapp* (BPI,F); Sanford, Jan. 1911, *Rapp 42* (F); on *Magnolia glauca*, Sanford, Apr. 1911, *Rapp 39* (F); Sanford, Apr. 1922, *Rapp 323* (F).
ALABAMA: LEE CO.: on fence rail, Auburn, Mar. 21, 1897, *Earle & Baker* (MBG, MIN).
OHIO: BROWN CO.: on fence, Apr. 18, 1936, *Wolfe & Hill 605* (O). CLERMONT CO.: on oak, Apr. 18, 1936, *Wolfe & Hill 609* (O). CLINTON CO.: on tree, Apr. 18, 1936 *Wolfe & Hill 626* (O). FAIRFIELD CO.: on rock, Apr. 27, 1935, *Wolfe 93* (O). MARION CO.: June 30, 1892, *Bogue* (O). PIKE CO.: on oak, Sept. 15, 1935, *Wolfe 209* (O). UNION CO.: on maple, May 3, 1936, *Wolfe & Hartley 657* (O). VINTON CO.: on red maple, Mar. 14, 1936, *Wolfe 474* (O). WARREN CO.: on hickory, Apr. 18, 1936, *Wolfe & Hill* (O).
KENTUCKY: KNOX CO.: open woods, 1.4 miles north of Jarvis Store, Aug. 10, 1937, *Hubricht B283, B321* (MBG).
TENNESSEE: HAMILTON CO.: on rocks, Lookout Mountain, *Calkins 204* (NYBG).
ARKANSAS: CHICOT CO.: near Macon, Dec. 29, 1938, *Anderson* (MBG).
OKLAHOMA: NOBLE CO.: on dead juniper, Fort Bliss, Apr. 18, 1917, *Mrs. J. Clemens* (MBG).
TEXAS: HARRIS CO.: on living *Quercus Phellos*, Houston, Jan. 9, 1939, *Fisher 392* (MBG). BLANCO CO.: on dead wood, Blanco, *Fink 11,427* (M); Blanco, *Wright 228* (Type collection) (T).

28. Parmelia rudecta Ach., Syn. Meth. Lich. 197. 1814.

Parmelia Borreri var. *rudecta* Tuck., Enum. N. Amer. Lich. 49. 1845.

Parmelia leiocarpa Tayl., Hook. London Jour. Bot. **6**: 170. 1847.

Acharius' type description was from a collection of Muhlenberg's made in Pennsylvania. Tuckerman's type of the variety was based on a collection from the White Mountains of New Hampshire, which is in his herbarium at the Farlow. Taylor's *P. leiocarpa* was based on a North American collection and is now in his herbarium at the Boston Society of Natural History. *Parmelia rudiata* Eaton (Manual of Botany for North America, ed. 6, pt. 2:56. 1833) is a typographical error which appeared in the sixth edition and was continued through the eighth edition. Previous to the sixth edition Eaton used *Parmelia rudecta.*

Thallus olive-green or lighter, wrinkled, loosely adnate, older portions covered with confluent soredia, granular isidia, or coralloid branchlets, lobes round, margins entire or slightly dissected; lower surface white to light brown or darker; apothecium 3–5 mm. diameter, sessile, disk deeply concave, chestnut-brown, amphithecium entire, wavy or irregular; K, upper cortex yellow, medulla none; C, upper cortex none, medulla red; K + C, yellow; P, gray.

Algal layer continuous, 42–45 μ thick; thickness of upper cortex 18–23 μ; medullary hyphae loosely interwoven, large, 3–4 μ in diameter; thickness of lower cortex 65–84 μ, thickness of thallus 400–810 μ; thecium 60–67 μ thick, ascus clavate, spores 8, 8–10 × 10–12 μ.

Distribution: Nova Scotia to Florida, west to Washington.

NOVA SCOTIA: on tree, Sandy Cove, Aug. 1908, *Lowe* (F); *Rothrock* (FM).

QUEBEC: on oak trunk, Hull, Sept. 28, 1907, *Macoun* (F); adherent to rocks, Ste. Anne, May 2, 1935, *Lepage 137* (D); on trees, Ste. Anne, May 5, 1935, *Lepage 142* (D).

ONTARIO: on bark of trees, Ottawa, Apr. 20, 1891, *Macoun 85* (MIN,MBG,WIS); on trunks and old rails, Ottawa, Oct. 15, 1893, *Macoun 40* (MBG); on ground, fallen trees, base of trees, in shaded parts of woods, Rainy Lake, Aug. 20, 1930, *Schmidt 11* (US); on rocks, Emo, July 20, 1901, *Fink 777* (MIN).

MAINE: HANCOCK CO.: on paths to cliffs, Seal Harbor, Sept. 20, 1894, *Merrill*

(D). KNOX CO.: on old birch trunks, Thomaston, Apr. 1912, *Merrill 2* (MBG). OXFORD CO.: on black ash, Buckfield, July 16, 1924, *Parlin 7419* (F).

NEW HAMPSHIRE: COOS CO.: White Mountains, *Tuckerman* (Type of *P. Borreri* var. *rudecta)* (T).

VERMONT: LAMOILLE CO.: on maple tree, Cambridge, June 21–24, 1922, *Dutton 1713* (MBG). WINDHAM CO.: on apple tree, Pike Hollow, Wardsboro, July 3, 1935, *Moore* (MBG). ADDISON CO.: over ledges, Mud Pond, Leicester, Aug. 28, 1922, *Dutton 1878* (F). RUTLAND CO.: on cedar tree in swamp, elev. 475 ft., Brandon, Feb. 26, 1921, *Dutton* (WIS,FM).

MASSACHUSETTS: BARNSTABLE CO.: on limb of white oak, West Falmouth, Apr. 11, 1937, *Linder* (F). BRISTOL CO.: on trunks, New Bedford, *Willey 26* (MBG).

CONNECTICUT: WINDHAM CO.: on trees, Woodstock, Oct. 29, 1925, *Evans* (F).

NEW YORK: QUEENS CO.: on trees, Long Island, 1914, *Lathrow 27* (F). YATES CO.: Dundee, *Samuel Wright* (FM).

PENNSYLVANIA: CHESTER CO.: on chestnut rail, Nov. 27, 1897, *Rothrock & Rothrock* (FM). LANCASTER CO.: along fence rails, Lancaster, Mar. 14, 1894, *Eby* (MBG); along mill creek, Lancaster, Nov. 22, 1892, *Heller* (F); on red cedar trees, Bear Town, Sept. 16, 1895, *Eby* (US); on trees, Rheinholds, Sept. 23, 1894, *Eby* (US); on tree, Bear Town, July 11, 1894, *Eby* (MBG); on tree, Apr. 1896, *Eby* (MBG). PIKE CO.: Matamoras, Sept. 24, 1896, *Schneider* (MBG).

MARYLAND: PRINCE GEORGES CO.: base of juniper tree, pine barren, southeast of Decatur Heights, Bladensburg, Sept. 26, 1938, *Leonard* (US). MONTGOMERY CO.: logs and bases of trees, Takoma Park, 1896, *Williams* (MBG,MIN,WIS); hickory tree, Plummers Island, Nov. 6, 1938, *Leonard* (US).

NORTH CAROLINA: STOKES CO.: on bark of trees, Germantown Road, Mar. 1, 1922, *Schallert 971* (WIS). FORSYTH CO.: Bennetts Rock, Apr. 10, 1936, *Schallert* (MBG).

SOUTH CAROLINA: COUNTY UNKNOWN: *Ravenel* (US).

GEORGIA: THOMAS CO.: Thomasville, Aug. 17, 1906, *Taylor* (F).

FLORIDA: ORANGE CO.: on trunks of trees, Sanford, Mar. 1910, *Rapp 40.11* (F).

ALABAMA: MARSHALL CO.: open woods, 3.2 miles north of Boaz, July 21, 1939, *Hubricht B1546* (MBG).

MISSISSIPPI: DE SOTO CO.: 2 miles north of Coldwater, Dec. 28, 1938, *Anderson* (MBG).

OHIO: VINTON CO.: on red maple, Mar. 14, 1936, *Wolfe 474* (O). HOCKING CO.: on tree trunk, Dec. 9, 1934, *Wolfe* (NYBG); PIKE CO.: on oak, Sept. 15, 1935, *Wolfe 209* (O). FRANKLIN CO.: Georgesville, July 15, 1892, *Bogue* (W). UNION CO.: on maple, May 3, 1936, *Wolfe 657* (O). CLARK CO.: Springfield, Feb. 9, 1877, *Biddlecome* (W). CLINTON CO.: on tree, Apr. 18, 1936, *Wolfe 626* (O). BROWN CO.: on fence, Apr. 18, 1936, *Wolfe 605* (O). FAIRFIELD CO.: on rock, Apr. 27, 1935, *Wolfe 93* (O). CLERMONT CO.: on oak, Apr. 18, 1936, *Wolfe 609* (O). WARREN CO.: on hickory, Apr. 18, 1936, *Wolfe & Hill 624* (O).

WEST VIRGINIA: LOGAN CO.: on Peach Creek, Pulaski, *Cummings* (W).

MICHIGAN: CHEBOYGAN CO: on *Betula,* Pap Island, vicinity of Burt and Douglas lakes, June–Aug. 1922, *Nichols* (F).

INDIANA: FRANKLIN CO.: on wood near Brookville, July 25, 1917, *Fink* (D). KNOX CO.: edge of woods, 1.3 miles east of Frichton, Aug. 16, 1937, *Hubricht B161* (MBG).

KENTUCKY: BALLARD CO.: Kevil, Apr. 1936, *Fassett* (WIS). ROCKCASTLE CO.: bark of trees, open pine woods near Rockcastle River east of Livingston, Aug. 18, 1937, *Hubricht B238* (MBG).

TENNESSEE: SEVIER CO.: semi-shade, boulders in stream bed, elev. 3600 ft., "The Loop," 10 miles south of Gatlinburg, Aug. 25, 1937, *Hubricht B507* (MBG). HAMILTON CO.: on pine tree, Lookout Mountain, *Calkins 3* (F).

WISCONSIN: DODGE CO.: northeast of Kekoskee, May 1936, *J. Thomson* (WIS). WAUSHARA CO.: sand plains south of Plainfield, Oct. 13, 1935, *J. Thomson* (WIS). MARQUETTE CO.: 12 miles east of Westfield, Oct. 13, 1935, *J. Thomson* (WIS). COLUMBIA CO.: Black Hawk Lookout, opposite Prairie du Sac, Sept. 28, 1935, *J. Thomson* (WIS). ADAMS CO.: Leola, Oct. 27, 1935, *J. Thomson* (WIS); bluffs of the Wisconsin River, Oct. 6, 1935, *J. Thomson* (WIS). BURNETT CO.: valley of the Wisconsin River, near Webster, summer 1894, *Cheney* (WIS).

ILLINOIS: LA SALLE CO.: on trees, *Calkins 401* (F). MENARD CO.: on fences and old wood, 1878, *Hall* (FM). COUNTY UNKNOWN: on limbs, Mar. 9, 1879, *Earle* (NYBG).

MINNESOTA: COOK CO.: on rocks, Grand Portage, June 24, 1897, *Fink 188* (MIN). LAKE CO.: on wood, Snowbank Lake, July 20, 1897, *Fink 839* (MIN). ST. LOUIS CO.: on rocks, Ely, July 28, 1897, *Fink 983* (MIN); on cedars, Tower, Aug. 26, 1901, *Fink 1788* (MIN). CARLTON CO.: on trees, Tafte, Carlton Peak, July 10, 1897, *Fink 612* (MIN); on rocks, Kettle Falls, Aug. 12, 1901, *Fink 1395* (MIN). KOOCHICHING CO.: on rocks, Rainy Lake City, Aug. 3, 1901, *Fink 1136* (MIN); on cedars, Koochiching, July 29, 1901, *Fink 989* (MIN); on rocks, Gunflint, July 1, 1897, *Fink 369* (MIN). AITKIN CO.: on rocks, Palisades, July 15, 1897, *Fink 744* (MIN); on *Acer saccharum*, Mille Lacs Lake, June 1892, *Sheldon S2622* (MIN). BLUE EARTH CO.: on old wood and trees, Mankato, June 22, 1899, *Fink 12* (MIN); on trees, Mankato, June 23, 1899, *Fink 58* (MIN). BELTRAMI CO.: on cedars in swamps, Beaudette, June 22, 1901, *Fink 114* (MIN); on shaded granite, Bemidji, July 1900, *Fink 674* (MIN); on cedars in swamps, Beaudette, June 22, 1901, *Fink 111* (MIN). YELLOW MEDICINE CO.: on rocks and near trees, Granite Falls, July 11, 1899, *Fink 383* (MIN). ROSEAU CO.: on cedars in swamps, Warroad, June 29, 1901, *Fink 267* (MIN).

IOWA: IOWA CO.: on bark of various trees, north exposure, moist canyon Iowa River, Amana, May 30, 1937, *Kiener* (MBG).

MISSOURI: ST. CHARLES CO.: bark of tree, bluff of Missouri River, Mar. 12, 1938, *Berry* (MBG). ST. LOUIS CO.: on oak tree, Centaur, 5 miles beyond Clayton, Apr. 24, 1898, *Ferguson* (MBG); on boulders, Ranken Estate, Sept. 28, 1935, *Moore* (MBG). JEFFERSON CO.: on *Juniperus*, Herculaneum, Oct. 25, 1935, *Moore* (MBG). ST. FRANCOIS CO.: bark of trees, Pickle Springs, May 21, 1938, *Berry* (MBG). IRON CO.: Iron Mountain, July 17, 1915, *Emig* (MBG). FRANKLIN CO.: bark of tree, Missouri Botanical Garden Arboretum, Gray Summit, May 2, 1938, *Berry* (MBG); Boat Rock, Oct. 20, 1935, *Moore* (MBG); Elmont, May 20, 1914, *Emig* (MBG). CALLAWAY CO.: bark of tree, Sept. 25, 1930, *Berry* (MBG). MILLER CO.: bark of tree, Tavern Creek, Iberia, *Drouet* (MBG). GREENE CO.: on tree, rocky wooded bank of James River, 8 miles south of Springfield, Apr. 7, 1939, *Dodge, Berry & Johnson* (MBG). JOHNSON CO.: bark of tree, Knobnoster, June 9, 1938, *Berry* (MBG).

ARKANSAS: WHITE CO.: near Judsonia, Dec. 28, 1938, *Anderson* (MBG). NEWTON CO.: top of dry wooded bluff with rocky flat top, 1 mile south of Ponca, Apr. 8,

1939, *Dodge, Berry & Johnson* (MBG); high bluff and long steep wooded hillside, Lookout Point, 7 miles south of Jasper, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG); steep wooded slope with limestone bluff at top, 4 miles south of Boxley, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG). BOONE CO.: rocky wooded bluff above creek bed, Bear Creek Spring, 0.5 mile north of Francis, Apr. 7, 1939, *Dodge, Berry & Johnson* (MBG).

TEXAS: HARRIS CO.: Houston, Feb. 24, 1917, *Fisher* (F); living tree, Harrisburg, Feb. 17, 1875, *Joor Herbarium* (MBG). BEXAR CO.: mesquite woods, 1.5 miles southeast of junction of Jolly Lane and Atkins-Elmendorf Lane, 18 miles east of San Antonio, May 17, 1939, *Hubricht B1887* (MBG).

WASHINGTON: JEFFERSON CO.: Olympic Mountains, 1915, *Grant* (F).

29. Parmelia reticulata Tayl. apud Mack., Fl. Hibern. 2: 148. 1836.

Taylor's type was a collection from the rocks near Dunkerron, County Kerry, Ireland. The type is in Taylor's Herbarium at the Boston Society of Natural History, Boston.

Thallus large, 15–20 cm. diameter; upper surface smooth, margins rarely sorediate, without cilia, rhizinae extending from the lower side, giving a superficial appearance of marginal cilia; lobes round and slightly dissected; lower surface brown at the margins, black with many black rhizinae at the center; apothecia rare, sessile, 2–6 mm. diameter, disks concave, chestnut-brown, margins of amphithecia smooth and regular; K, upper cortex yellow, medulla red-brown; C, none; K + C, none; P, none.

Algal layer continuous, 160–180 μ thick; upper cortex 36–40 μ thick, matrix light brown or yellowish; medulla of loosely interwoven hyphae of small diameter and of one type; lower cortex 48–60 μ thick, matrix black; thickness of thallus 304–350 μ; thecium 80–90 μ thick, ascus clavate, spores 8, 6–8 × 12–16 μ; paraphyses branched, enlarged at the tips.

Distribution: Pennsylvania to North Carolina, west to Minnesota.

PENNSYLVANIA: LANCASTER CO.: *Small* (MBG); Russell Hill, July 1895, *Eby* (MBG).

NORTH CAROLINA: HENDERSON CO.: on the bark of trees, Flat Rock, Mar. 1, 1921, *Schallert* (MBG).

TENNESSEE: HAMILTON CO.: Lookout Mountain, *Calkins* (MBG).

MINNESOTA: YELLOW MEDICINE CO.: on shaded rocks, Granite Falls, July 17, 1899, *Fink 574* (MIN); on rocks, Redwood Falls, July 8, 1899, *Fink 360* (MIN).

30. Parmelia cetrata Ach., Syn. Meth. Lich. 198. 1814.

Acharius based his description on collections from North America, probably Muhlenberg's from Pennsylvania. The type is in Helsinki, Finland, and there is a co-type in Upsala, Sweden.

Thallus large, 10–20 cm. diameter, loosely adnate; upper surface wrinkled, but unbroken except at the margins where it is usually sorediate and somewhat ciliate, lobes short and wide or somewhat elongated and branched, usually ascending toward the margins; lower surface black with numerous black rhizinae, margins brown; apothecia rare, 4–15 mm. diameter, subpedicellate, disks deeply concave, chestnut-brown, commonly perforate at the center, amphithecia entire or fissured, regular or crenulate; K, none, C, none, K + C, none, P, none.

Algal layer continuous, 15–21 μ thick; upper cortex 12–15 μ with a yellow matrix; medulla of small, loosely interwoven, hyaline hyphae of one type; lower cortex 9–20 μ thick, matrix black or dark brown; thallus 165–180 μ thick; thecium 24–26 μ thick, ascus clavate or oval, 8-spored, spores 6–7 × 7–9 μ.

Distribution: New Hampshire to Florida, west to Alaska and British Columbia.

NEW HAMPSHIRE: CARROLL CO.: on bark of very old *Fagus* in deep woods, Jaffrey, Aug. 1918, *Riddle* (F).

NEW YORK: COUNTY UNKNOWN: Port Jervis, *Buckley* (US).

MARYLAND: MONTGOMERY CO.: on cedar bark, Plummers Island, Aug. 18, 1907, *Fink* (M); dead limb, west side of Cabin Hill, Plummers Island in the Potomac River, near Cabin John, Nov. 6, 1938, *Leonard* (US).

DISTRICT OF COLUMBIA: on rotten log, wooded bank of Rock Creek, northern corner of D. C., Apr. 25, 1908, *Mary Miller* (US).

VIRGINIA: COUNTY UNKNOWN: July 17, 1891, *Seymour 1591* (F).

NORTH CAROLINA: HENDERSON CO.: on the bark of trees, Flat Rock on Warburg Road, June 1, 1922, *Schallert* (MBG,FM,WIS). MITCHELL CO.: on tree roots, Roan Mountain, June 15, 1936, *Schallert* (MBG).

GEORGIA: THOMAS CO.: Thomasville, Aug. 1906, *E. B. Taylor* (F). DE KALB CO.: on the summit of Stone Mountain, elev. 1686 ft., *Small* (M).

FLORIDA: ORANGE CO.: on trees, Sanford, Mar. 1922, *Rapp* (BPI); on trees, vicinity of Oviedo, May 1923, *Rapp* (BPI).

ALABAMA: LEE CO.: Auburn, Jan. 9, 1897, *Earle & Baker* (US).

MISSISSIPPI: HANCOCK CO.: on pine bark, Bay of St. Louis, Mar. 28, 1885, *Langlois* (W).

LOUISIANA: ST. MARTIN CO.: on trunk of tulip tree, near swamp, St. Martinsville, Sept. 22, 1896, *Langlois* (NYBG); Dec. 7, 1898, *Langlois* (US).

OHIO: CHAMPAIGN CO.: in cedar swamp, *Werner L426* (O). FRANKLIN CO.: on sycamore trunk, Slate Run, Columbus, Nov. 7, 1907, *H.S.B.* (O).

KENTUCKY: BELL CO.: woods, north side of Pine Mountain, 5.5 miles east of Pineville, Aug. 19, 1937, *Hubricht B337* (MBG). MADISON CO.: glade, 10 miles north of Richmond, Aug. 18, 1937, *Hubricht B200* (MBG). ROCKCASTLE CO.: open woods, 3.3 miles south of Berea, on Madison-Rockcastle county line, Aug. 18, 1937, *Hubricht B227* (MBG); bark of tree, open pine woods near Rockcastle River, east of Livingston, Aug. 18, 1937, *Hubricht B253* (MBG).

TENNESSEE: COUNTY UNKNOWN: on rocks, *Calkins* (FM).

WISCONSIN: LINCOLN CO.: on trees, Merrill Springs, May 30, 1893, *Head & Buell* (WIS).

ILLINOIS: JACKSON CO.: on sandstone boulders near Bat Cave, 5 miles southwest of Pomona, Apr. 14, 1940, *Hubricht B1736* (MBG). LA SALLE CO.: on bark of trees, *Calkins* (FM). COOK CO.: on trees, *Calkins* (FM).

MINNESOTA: KOOCHICHING CO.: on rocks, Gunflint, July 1, 1897, *Fink 362* (MIN). BELTRAMI CO.: on oak, Bemidji, July 12, 1900, *Fink 691* (MIN). REDWOOD CO.: on cedar, Redwood Falls, July 8, 1899, *Fink 329* (MIN). YELLOW MEDICINE CO.: on shaded rocks, Granite Falls, July 17, 1899, *Fink 573* (MIN).

IOWA: CLAYTON CO.: on trees, Sept. 1894, *Fink* (MIN); on trees, July 1897, *Freuring* (MBG). FAYETTE CO.: on trees, Apr. 1894, *Fink* (MBG). EMMETT CO.: on base of tree, bank of Mud Lake, Dec. 17, 1917, *Walden* (BPI).

MISSOURI: ST. FRANCOIS CO.: on bark of tree, open woods, Pickle Springs, May 21, 1938, *Berry* (MBG). LINCOLN CO.: July 1897, *Freuring* (MBG). GREENE CO.: rocky wooded bank of James River, 8 miles south of Springfield, Apr. 7, 1939, *Dodge, Berry & Johnson* (MBG).

ARKANSAS: GARLAND CO: dry ridge, water works, Hot Springs, June 10, 1940, *Scully* (MBG). BAXTER CO.: dry upland woods, 1 mile west of Big Flat, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG). SEARCY CO.: open wooded hillside, 4 miles west of Marshall, Apr. 9, 1939, *Dodge, Berry & Johnson* (MBG). BOONE CO.: rocky wooded bluff, above dry creek bed, Bear Creek Spring, 0.5 mile north of Francis, Apr. 7, 1939, *Dodge, Berry & Johnson* (MBG). NEWTON CO.: high bluff and long steep wooded hillside, Lookout Point, 7 miles south of Jasper, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG); moist woods on gentle slope near Marble Falls, 11 miles south of Harrison, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG); steep, dry wooded bluff with rocky flat top, 1 mile south of Ponca, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG).

OKLAHOMA: MURRAY CO.: Arbuckle Mountains, Nov. 29, 1914, *Emig* (US). MC CURTAIN CO.: on dead branches, grassy lake, 13 miles southeast of Broken Bow, *Stratton 78* (M).

TEXAS: BRAZOS CO.: on oak, 8 miles south of College Station, Apr. 21, 1936, *Hubricht* (MBG). GILLESPIE CO.: *Jermy* (MBG).

ALASKA: Juneau, Dec. 5, 1924, *Fink* (M).

BRITISH COLUMBIA: New Westminster, Jan. 1903, *Macoun* (F).

30a. Parmelia cetrata var. **subisidiosa** Müll.-Arg., Engler's Bot. Jahrb. **15**: 256. 1894.

The type of the variety was from Cuba, and is in Geneva, Switzerland.

Margin of thallus beset with heavy black cilia; lower surface black with heavy black rhizinae; spore measurements, internal morphology of the thallus, and chemical reactions same as in the species.

Distribution: South Louisiana.

LOUISIANA: NEW ORLEANS CO.: on hardwoods near Indian Village, New Orleans, Dec. 31, 1931, *Dodge* (D).

31. Parmelia Hubrichtii Berry, sp. nov.

Type: Missouri Botanical Garden Herbarium, *No. 154725.*

Type locality: open woods, 1.4 miles north of Jarvis Store, Knox County, Kentucky.

Thallus 2–8 cm. diameter, loosely adnate to bark of trees; lobes small, round, dissected and somewhat imbricated, margins flat, light greenish-gray becoming darker at the center; upper cortex slightly wrinkled except at the margins, completely covered with small isidia; lower surface dark olivaceous-brown to black with a lighter margin, rhizinae black, numerous and long at the center of the thallus, at the margins smaller but not papillose; apothecium sessile, 1–5 mm. diameter, deeply concave, disk chestnut-brown, amphithecium covered with isidia or coralloid branchlets; K, upper cortex yellowish-green, medulla unchanged, C, none, K + C, none, P, none.

Algal layer continuous, 25–40 μ thick; upper cortex 12–16 μ thick, matrix yellow; medulla loosely interwoven, hyphae hyaline and of one type; lower cortex 25–30 μ thick, matrix black; thickness of thallus 120–150 μ; thecium 52–56 μ thick; ascus ovate-clavate, spores 8, 8–9 × 12–16μ; paraphyses branched, tips with oval enlargements; spermagonia spherical, immersed, upper half of walls brown, lower half hyaline, 128 μ diameter, spermatia slender and straight.

Thallus 2–8 cm. diametro, adnatus ad corticem; laciniae minimae rotundae, marginibus planis undulato-crenulatis et parvis isidiis tectis; superficies supra viridis, subtus nigra, rhizinis multis nigris; stratum superior 12–16 μ crassitudine; medulla laxe reticulata, hyphis hyalinis; stratum gonidiale continuum, 25–40 μ crassitudine; algae protococcideae; stratum inferior 25–30 μ crassitudine; thallus 120–150 μ crassitudine; stratum

superior KOH addito flavo-virescens, medulla non mutans, $CaOCl_2$ addito stratum superior et medulla non mutantes; KOH et $CaOCl_2$ addito non mutans; apothecium 1–5 mm. diametro, sessile, discus concavus rufo-brunneus, amphithecium ramulis coralloideis vel isidiis ramosis tectum; thecium 52–56 μ crassitudine; asci ovato-clavati, sporae 8-nae, 8–9 μ crassitudine, 12–16 μ longitudine, ellipsoideae; paraphyses ramosi, hyalini, apicibus globosis; spermagonia immersa, globosa, muris brunneis, 128 μ diametro, spermatia tenuia et recta.

Distribution: Kentucky to Alabama and west to Arkansas and Texas.

ALABAMA: MARSHALL CO.: open woods, 3.2 miles north of Boaz, July 21, 1939, *Hubricht B1545* (MBG).

MISSISSIPPI: MONROE CO.: 4 miles south of Nettleton, July 16, 1939, *Hubricht B1532* (MBG).

KENTUCKY: KNOX CO.: open woods, 1.4 miles north of Jarvis Store, Aug. 19, 1937, *Hubricht B305* (Type collection) (MBG). ROCKCASTLE CO.: on bark of trees, open pine woods, near Rockcastle River, east of Livingston, Aug. 18, 1937, *Hubricht B242* (MBG).

ARKANSAS: NEWTON CO.: dry wooded hillside, 9 miles south of Boxley, Boston Mountains, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG). CONWAY CO.: Petit Jean State Park, May 5, 1940, *Hubricht B1921* (MBG).

TEXAS: GILLESPIE CO.: *Jermy 429* (MBG). BEXAR CO.: mesquite woods, 18 miles east of San Antonio, May 17, 1940, *Hubricht B1926* (MBG).

32. Parmelia erecta Berry, sp. nov.

Type: Missouri Botanical Garden Herbarium, *No. 154724.*

Type locality: moist woods on gentle slope near Marble Falls, 11 miles south of Harrison, Newton County, Arkansas.

Thallus large, 10–20 cm. diameter, loosely adnate to bark of trees and bushes, habit of growth distinctly fruticose; upper surface smooth, margins crenulate, not sorediate, and beset with black cilia, but always thin and without a break between the upper and lower cortex; lobes wide, short and rounded, irregularly incised, light mineral-gray when dry, becoming grape-green when wet, younger portion covered with black ostioles of spermagonia; lower surface finely reticulate on raised portions, margins colored like the upper surface, when in contact with the substratum dark brown to black and thickly covered with short black rhizinae; apothecia numerous, 1–22 mm. diameter, subpedicellate and usually perforate when

mature, disk flat, light brown, margin of amphithecium irregularly crenulate and smooth; K, none, C, yellow, K + C, yellow, P, yellow.

Algal layer continuous, 21–22 μ thick; upper cortex 18–20 μ thick; lower cortex 27–30 μ thick at the center of the thallus and 15–23 μ thick at the margins, matrix black; thallus 515–530 μ thick; thecium 30–35 μ thick, ascus clavate, spores 8, 5–6 × 8–9 μ; paraphyses simply branched; spermagonia spherical, 185–192 μ diameter, wall light-colored or hyaline below, dark above, spermatia straight and pointed.

Thallus laxe adnatus, pallidus aridus, vito-viridis humidus, juventate habitu fruticosissimo, lobi marginibus rotundis, sublati, rugosi, nigro-ciliati, partes juniores loborum ostiolis nigris spermagoniorum tectae; cortex superior 18–22 μ crassitudine, pseudoparenchymaticus, non sorediatus sed semper tenuis et sine ruptis inter illum et inferiorem corticem; cortex inferior minute reticulatus marginibus viridibus ut in cortice superiori, dilutior siccatus, rhizinis nigris tectus; medulla hyphis hyalinis dispersis; stratum gonidiale 21–22 μ crassitudine; cortex inferior cellulis pachydermaticis, nigrescens, 27–30 μ crassitudine; apothecia numerosa, sessilia, rotunda vel angulosa, 1–22 mm. diametro, marginibus non ciliatis, gonidiis sub excipulo et hymenio; thecium 30–35 μ crassitudine, asci clavati, octospori, sporae 5–6 μ crassitudine, 8–9 μ longitudine, hyalinae; spermagonia numerosa, immersa, globosa, 185–192 μ.

Distribution: North Carolina to Georgia, west to Texas.

NORTH CAROLINA: COUNTY UNKNOWN: on bark, Oct. 23, 1932, *Schallert* (MBG). YADKIN CO.: on tree branch, Lime Rock, May 12, 1936, *Schallert* (MBG).

ALABAMA: LEE CO.: on limbs, Auburn, Jan. 1, 1897, *Earle & Baker* (MIN).

LOUISIANA: ST. MARTIN CO.: on trees, St. Martinsville, 1893, *Langlois* (MIN).

MISSISSIPPI: MONROE CO.: 4 miles south of Nettleton, July 16, 1939, *Hubricht B1535* (MBG).

KENTUCKY: MADISON CO.: glade, 10 miles north of Richmond, Aug. 18, 1937, *Hubricht B1406* (MBG). KNOX CO.: open woods, 1.4 miles north of Jarvis Store, Aug. 19, 1937, *Hubricht B298* (MBG).

TENNESSEE: HAMILTON CO.: on bark, Chattanooga, *Calkins 284* (MIN).

ILLINOIS: COUNTY UNKNOWN: on trees, 1878, *Hall* (FM).

MISSOURI: ST. FRANCOIS CO.: bark of tree, Pickle Springs, May 21, 1938, *Berry* (MBG). IRON CO.: Royal Gorge, 3 miles east of Arcadia, Nov. 19, 1939, *Hubricht*

B1726 (MBG). WAYNE CO.: old trees, Williamsville, Mar. 1898, *C. Russell* (MBG).

ARKANSAS: IZARD CO.: on bark of trees, rocky hillside, 10 miles north of Melbourne, Apr. 9, 1939, *Dodge, Berry & Johnson* (MBG). SEARCY CO.: on bark of trees, open wooded hillside, 4 miles west of Marshall, Apr. 9, 1939, *Dodge, Berry & Johnson* (MBG). BOONE CO.: on bark of tree, rocky wooded bluff above dry creek bed, Bear Creek Spring, 0.5 mile north of Francis, Apr. 7, 1939, *Dodge, Berry & Johnson* (MBG). NEWTON CO.: on bark of tree, moist woods on gentle slope near Marble Falls, 11 miles south of Harrison, Ozark Mountains, Apr. 8, 1939, *Dodge, Berry & Johnson* (Type collection) (MBG); on branches of dead hackberry tree, high bluff and long steep wooded hillside, Lookout Point, 7 miles south of Jasper, Boston Mountains, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG); on dead branch, steep dry wooded bluff with rocky flat top, 1 mile south of Ponca, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG); dry wooded hillside, 9 miles south of Boxley, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG).

TEXAS: WALLER CO.: on living *Xanthoxylum*, Hemstead, elev. 140 ft., Feb. 15, 1939, *Fisher 3928* (MBG). BEXAR CO.: mesquite woods, 1.5 miles southeast of junction of Jolly Lane and Atkins-Elmendorf Lane, 18 miles east of San Antonio, May 17, 1940, *Hubricht B1889* (MBG). BRAZORIA CO.: on oak fence post, Brazoria, elev. 50 ft., Feb. 8, 1939, *Fisher 3916* (MBG); on dead branches of *Quercus* sp., West Columbia, elev. 40 ft., Feb. 8, 1939, *Fisher 3914* (MBG). BRAZOS CO.: on dead branches of trees, 8 miles south of College Station, Apr. 21, 1936, *Hubricht* (MBG). GILLESPIE CO.: *Jermy* (MBG). REAL CO.: shade, Frio Canyon, 11 miles north of Leakey, May 23, 1938, *Hubricht B775* (MBG).

33. **Parmelia livida** Tayl., Hook. London Jour. Bot. **4**: 171. 1847.

The type was collected near New Orleans, Louisiana, and is now in the Taylor Herbarium at the Boston Society of Natural History.

The distribution of this species is almost entirely tropical. It has been collected abundantly in Central America and northern South America.

Thallus small, adnate, upper surface smooth, shining, light gray to greenish-gray; lobes long, narrow, subdichotomously branched, margins smooth, closely adhering to the bark of trees; lower surface black with numerous black rhizinae which extend beyond the margin of the thallus; apothecia rare, small, 4–8 mm. diameter, disks flat, dark brown or blackish, amphithecia smooth, margins unbroken by fissures; K, none, C, medulla orange-brown, K + C, brown, P, orange.

Algal layer continuous, 12–15 μ thick; upper cortex 9–12 μ thick, matrix yellow or light brown; medulla loosely inter-

woven, hyphae hyaline and of one type; lower cortex 12–14 μ thick, matrix black; thallus 120–155 μ thick; thecium 45–60 μ thick; ascus cylindrical, spores 8 in a single row, 4–6 × 9–12 μ; paraphyses branched, very thin and pointed.

Distribution: Florida to Louisiana.

FLORIDA: ALACHUA CO.: red maple, near Gainesville, Mar. 14, 1938, *Murrill* (MBG). DUVAL CO.: Jacksonville, *Calkins* (MBG). ORANGE CO.: on trees, Sanford, Mar. 1918, *Rapp 641* (F).

LOUISIANA: ORLEANS CO.: New Orleans, *Taylor* (Type collection) (BSNH). ST. LUCIE CO.: Bois Levert, July 12, 1894, *Langlois* (US).

34. Parmelia Finkii Zahl. apud Hedr., Mycologia **26**: 162. 1934.

The type was collected by C. Russell at Williamsville, Wayne County, Missouri, and is No. 8943, Herbarium of University of Michigan.

Thallus small, 20–25 mm. diameter, closely adnate to bark of trees; upper surface granular with small soredia, isidia or coralloid branchlets; upper cortex cracked into areolate sections, small irregular breaks being left by the detachment of the isidia; lower surface black with many short black rhizinae; apothecium small, 0.4–3 mm. diameter, disk concave, chestnut-brown, margin of amphithecium dissected or formed by flat lobes which are covered with soredia and isidioid branchlets; K, none, C, medulla faint red; K + C, red; P, none.

Algal layer continuous, 16–24 μ thick; upper cortex 20–25 μ thick; medulla loosely interwoven, hyphae of small diameter and of one type; lower cortex 40–45 μ thick, matrix dark brown or black; thickness of thallus 140–200 μ; thecium 40–45 μ thick; ascus clavate, spores 8, 5–6 × 8–10 μ; paraphyses branched, enlarged at the tips.

Distribution: Found only in Missouri.

MISSOURI: WAYNE CO.: on bark, Williamsville, Mar. 1898, *C. Russell* (Type collection) (M); on calcareous rocks, Williamsville, Mar. 3, 1898, *C. Russell 119* (MBG). JEFFERSON CO.: on *Juniperus virginianus*, Vineland, June 1898, *C. Russell* (MBG).

35. Parmelia caroliniana Nyl., Flora **68**: 614. 1885.

The type was from Aiken, South Carolina, and is *Ravenel 404* in Tuckerman's Herbarium.

Thallus light grayish-green, wrinkled, covered with coralloid branchlets, lobes narrow, with dissected wavy margins; lower surface dark brown to black, with scattered rhizinae; apothecium 2–4 mm. diameter, disk concave when young, flat when mature, light brown, amphithecium with isidia or branchlets; K, brown, C, yellow, K + C, brown, P, none.

Algal layer discontinuous, groups of algal cells 6–15 μ in diameter; upper cortex 22–24 μ thick; lower cortex 7–9 μ thick; medulla of loosely interwoven hyphae; thallus 127–154 μ thick; thecium 20–26 μ thick; ascus clavate, spores 8, 5–7 × 8–9 μ; paraphyses branched once or twice.

Distribution: South Carolina to Florida, west to Alabama.

SOUTH CAROLINA: AIKEN CO.: Aiken, 1854, *Ravenel 404* (Type collection) (T). COUNTY UNKNOWN: *Curtis* (NYBG).

FLORIDA: ORANGE CO.: on wild cherry, Sanford, *Rapp* (F); on oak, Sanford, Dec. 1923, *Rapp 410* (F).

ALABAMA: LEE CO.: Auburn, Jan. 9, 1897, *Earle & Baker 4* (NYBG).

TENNESSEE: COUNTY UNKNOWN: on trees, *Calkins* (FM).

36. Parmelia sublaevigata Nyl., Ann. Sci. Nat. Bot. V, **7**: 306. 1867.

Parmelia tiliacea var. *sublaevigata* Nyl., Syn. Lich. **1**: 383. 1860.

Nylander's type of the variety was from South Africa, and is now in his Herbarium in Helsinki, Finland.

Thallus variable in size, 4–20 cm. diameter, upper surface smooth, greenish-gray, without soredia or wrinkles; lobes alternately dissected, with a black fringe of the rhizinae extending from under the margin; lower surface with a dense covering of black rhizinae; apothecium 2–10 mm. diameter, sessile, disk flat or deeply concave, chestnut-brown; K, brown, C, none, K + C, none, P, none.

Algal layer continuous, 40–50 μ thick; upper cortex 28–30 μ thick, matrix light brown; medulla of loosely interwoven, hyaline hyphae of small diameter; lower cortex 32–36 μ thick, matrix black; thallus 120–140 μ thick; thecium 52–58 μ thick; ascus clavate, spores 8, 5–6 × 6–8 μ; paraphyses branched.

Distribution: North Carolina to Florida, west to California.

NORTH CAROLINA: MITCHELL CO: on bark, Roan Mountain, June 15, 1936, *Schallert* (MBG); 1921, *Schallert* (F).

SOUTH CAROLINA: COUNTY UNKNOWN: *Ravenel* (MBG,BSNH).

FLORIDA: ORANGE CO.: on trees, Sanford, Apr. 1923, *Rapp* (BPI). DUVAL CO.: on *Taxodium*, near Jacksonville, *Calkins 5* (MBG,F); on *Andromeda*, Apr. 1923, *Rapp* (MBG); on trees, Jacksonville, *Calkins 2* (MIN).

ALABAMA: BALDWIN CO.: on trees, Fairhope, Oct. 17, 1924, *Evans* (F,NYBG); on tree, Fish River, Nov. 23, 1924, *Evans* (NYBG).

LOUISIANA: TANGIPAHOA CO.: on fence of old cypress pickets, Mar. 7, 1894, *Langlois* (NYBG); cypress swamp, 3 miles south of Ponchatoula, Mar. 26, 1937, *Johnson 215* (MBG).

KENTUCKY: KNOX CO.: open woods, 1.4 miles north of Jarvis Store, Aug. 19, 1937, *Hubricht B297* (MBG).

TENNESSEE: SEVIER CO.: woods, elev. 1600 ft., Great Smoky Mountains, 3 miles southwest of Gatlinburg, Aug. 25, 1937, *Hubricht B466* (MBG).

ILLINOIS: FULTON CO.: on oak, Canton, *Wolf* (NYBG).

MISSOURI: BOONE CO.: on bark of tree, Ashland, May 10, 1936, *Wilson* (B).

ARKANSAS: GARLAND CO.: on bark of pine tree, Hot Springs, Jan. 2, 1939, *Scully 1303* (MBG). CHICOT CO.: near Macon, Dec. 29, 1928, *E. Anderson* (MBG). BOONE CO.: on rock, rocky wooded bluff, above dry creek bed, Bear Creek Spring, 0.5 mile north of Francis, Apr. 7, 1939, *Dodge, Berry & Johnson* (MBG). NEWTON CO.: on bark, moist woods on gentle slope near Marble Falls, 11 miles south of Harrison, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG); on bark, high bluff and long steep wooded hillside, Lookout Point, 7 miles south of Jasper, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG); bark of tree, dry wooded hillside, 9 miles south of Boxley, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG).

TEXAS: BRAZORIA CO.: on branch of oak, West Columbia, Feb. 1939, *Fisher* (MBG). GALVESTON CO.: Galveston, *Hall* (US).

CALIFORNIA: SAN DIEGO CO.: San Diego, *Orcutt 4782* (US).

37. Parmelia cubensis Nyl., Flora **68**: 611. 1885.

The type is Charles Wright, Lichenes Cubae, 76, which was collected on the southeast coast of the Island of Cuba, and is now in Nylander's Herbarium, at Helsinki, Finland.

Thallus small, adnate, lobes narrow, imbricated from the center of the thallus, with small rounded lobules arising from the margins; upper surface smooth, greenish-yellow, well covered with the black ostioles of the spermagonia; lower surface light brown, thickly covered with short brownish or black rhizinae; apothecium sessile, 0.75–2 mm. diameter, margin of amphithecium smooth or occasionally dissected, disk concave, light brown; K, none, C, none, K + C, none, P, yellow.

Algal layer discontinuous, groups of algae 5–19 μ in diameter, upper cortex 22–25 μ thick; medulla of loosely interwoven hyphae of one type; lower cortex 7–9 μ thick; thallus 150–217 μ

thick; thecium 41–44 μ thick; ascus clavate, spores 8, 5–6 × 7–9 μ; paraphyses branched, thin and pointed at the tip.

Distribution: Virginia to Florida, west to Texas.

VIRGINIA: JAMES CITY CO.: Williamsburg, Apr. 17, 1911, *Farlow* (F).
FLORIDA: ORANGE CO.: on trunk of palmetto, Sanford, *Rapp* (BPI).
ALABAMA: BALDWIN CO.: on tree, near Fish River, Mar. 22, 1925, *Evans* (NYBG); on live oak, Yupon Point, Mar. 1, 1925, *Evans 201* (F); on tree, Mar. 27, 1925, *Evans 371* (F).
LOUISIANA: PLAQUEMINES CO.: on live oak, Pointe a la Hache, July 4, 1885, *Langlois 101* (NYBG).
TEXAS: BREWSTER CO.: common on rocks, north side of Mount Emory, Feb. 18, 1934, *Warwick* (MBG).

38. Parmelia laevigata (Sm.) Ach., Syn. Meth. Lich. 212. 1814.

Lichen laevigatus Sm. apud Sowerb., Eng. Bot. **26**: *tab. 1852.* 1808.

Parmelia sinuosa var. *laevigata* Schaer., Enum. Crit. Lich. Eur., 43. 1850.

Smith's type was collected by Rev. Hugh Davies in Caernavonshire, Wales. The present location of the type is unknown. Smith presents in Sowerby's 'English Botany' a drawing which represents the description. In transferring the species to the genus *Parmelia,* Acharius evidently saw Smith's type, but there is no record of the type in Acharius' Herbarium. Schaerer cites 'Lichenes Helvetici Exsiccati,' 561, as the type of the variety.

Thallus 5–15 cm. diameter, thin, loosely attached to substratum; upper surface free from wrinkles or ridges, sometimes slightly sorediate; lobes narrow and somewhat imbricated, subdichotomously branched, rhizinae extending from beneath the margins, margins never ciliate; lower surface black to the margin, with numerous small black rhizinae; apothecium small, 3–6 mm. diameter, sessile, disk concave, chestnut-brown, amphithecium entire or serrate; K, medulla brown, upper cortex yellow; C, none, K + C, none, P, orange.

Algal layer continuous, 16–20 μ thick; upper cortex 20–25 μ thick, matrix brown; medulla loosely interwoven, of hyaline hyphae of small diameter; lower cortex 20–30 μ thick, matrix

black; thecium 52–55 μ thick; ascus clavate, spores 8, 5–7 × 9–16 μ; paraphyses branched.

Distribution: Nova Scotia to Vermont, west to Missouri.

NOVA SCOTIA: *Menzies* (US).

VERMONT: COUNTY UNKNOWN: on bark of tree, *Knowlton* (US).

MISSOURI: PULASKI CO.: on chert rocks, open woods, 2 miles north of Hanna, Oct. 8, 1938, *Hubricht B1708* (MBG).

TEXAS: BRAZORIA CO.: on dead branches of *Quercus* sp., elev. 40 ft., West Columbia, Feb. 8, 1939, *Fisher* (MBG).

LOCAL AND FOREIGN EXSICCATAE EXAMINED: Bohl. *110;* Claud. *258;* Cromb. *141;* Harm. Lich. Loth. *289;* Larb. Caes. *64;* Larb. Herb. *124, 293;* Malbr. *268, 370;* Salw. *235;* Spruce, *132, 176.*

39. Parmelia endoxantha Merrill, Bryol. **12.** 73. 1909.

The type is *Rapp XII,* in the Farlow Herbarium. The collection is from Sanford, Florida.

Thallus large, loosely adnate, surface smooth, dark shiny brown, becoming crustose and granular in the center; lobes radiating from the center, margins smooth and crinkled; lower surface olivaceous-brown, with many small light-colored rhizinae; cortex unbroken; apothecium sessile, 1–3 mm. diameter, disk slightly concave or flat, chestnut-brown, margin of amphithecium slightly incurved and dissected; K, medulla and upper cortex greenish-yellow; C, none, K + C, yellow, P, yellow.

Algal layer continuous, 8–14 μ thick; upper cortex 15–21 μ thick, hyphae of small diameter; medulla of very loosely interwoven large hyaline hyphae; lower cortex 15–18 μ thick; thecium 60–64 μ thick; ascus clavate to oval, spores 8, 6–7 × 8–9 μ, almost globose; paraphyses branched and enlarged at the tips.

Distribution: found only in Florida.

FLORIDA: ORANGE CO.: on bark, Sanford, July 1907, *Rapp XII* (Type collection) (F); on trunk of *Magnolia glauca,* Sanford, Oct. 6, 1907, *Rapp 5* (F); on palmetto, Sanford, May 3, 1908, *Rapp 1* (F); on palmetto, Sanford, July 1917, *Rapp 16* (F). LEE CO.: on cypress trunk, vicinity of Fort Myers, Mar. 4, 1916, *Standley 13084* (US). DUVAL CO.: on cypress bark, Jacksonville, *Calkins* (FM, MIN).

40. Parmelia aurulenta Tuck., Amer. Jour. Arts & Sci. II, **25**: 424. 1858.

The type was from Crawfords Gap, in the White Mountains of New Hampshire, and is now in Tuckerman's Herbarium at the Farlow.

Thallus varying from small to large, lobes short and round, margins dissected; upper surface wrinkled and covered with scattered or confluent, yellowish-green soredia; lower surface, brown to black with numerous small black rhizinae to the margin; apothecium 4–12 mm. diameter, sessile, disk concave, chestnut-brown, amphithecium often sorediate; K, medulla brown, C, none, K + C, brown, P, brown.

Algal layer continuous, 8–12 μ thick; upper cortex 9–12 μ thick; medulla of loosely interwoven, yellow hyphae; lower cortex 14–16 μ thick, matrix black; thallus 70–88 μ thick; thickness of thecium 20–25 μ; ascus clavate, spores 8, 9–10 × 12–17 μ; paraphyses unbranched.

Distribution: Quebec to Florida, west to Minnesota.

QUEBEC: on spruce, Ste. Anne, May 5, 1935, *Lepage 133* (D).

ONTARIO: on trunks, Ottawa, May 10, 1907, *Macoun 200.07* (F).

MAINE: KNOX CO.: boulder in shaded places, Megunticook Lake, Camden, Aug. 13, 1913, *Merrill* (F).

NEW HAMPSHIRE: COOS CO.: White Mountains, near Crawford's Gap, 1844, *Tuckerman* (Type collection) (T).

VERMONT: RUTLAND CO.: on *Ostrya virginiana,* Haystack Mountain, Pawlet, Aug. 25, 1913, *Dodge 158* (D).

CONNECTICUT: TOLLAND CO.: Union, June 18, 1927, *Evans 1180* (F). MIDDLESEX CO.: on shaded rocks, East Hampton, May 14, 1927, *Evans 1053* (F). FAIRFIELD CO.: Oct. 26, 1926, *Evans 853* (F).

MARYLAND: BALTIMORE CO.: on rocks near Baltimore, 1909, *Plitt* (WIS,MBG, FM); on rock in woods along Gwynns Falls path, Sept. 19, 1905, *Merrill 101b* (F). MONTGOMERY CO.: on hickory tree, west knoll, Plummers Island, near Cabin John, Nov. 6, 1939, *Leonard 2781* (MBG).

VIRGINIA: FAIRFAX CO.: Great Falls Park, July 25, 1931, *Plitt* (BPI); Harpers Ferry, 1889, *Lehnert* (US).

NORTH CAROLINA: HENDERSON CO.: on exposed rock, Flat Rock School House, June 1, 1922, *Schallert 6153* (WIS); on bark of tree, Flat Rock, May 5, 1922, *Schallert* (WIS). FORSYTH CO.: bark of tree, June 13, 1934, *Schallert* (MBG); Haines Town, June 6, 1922, *Chapman 917L* (F). CHATHAM CO.: Bennetts Rock, Apr. 10, 1936, *Schallert* (MBG). COUNTY UNKNOWN: on bark of tree, South Mountain, May 1, 1934, *Schallert* (MBG).

SOUTH CAROLINA: COUNTY UNKNOWN: on trees, *Calkins* (FM).

FLORIDA: ORANGE CO.: on *Myrica,* Sanford, *Rapp 317* (F).

ALABAMA: COUNTY UNKNOWN: 1852, *Peters* (T).

OHIO: COUNTY UNKNOWN: 1880, *Eckfeldt* (T).

ILLINOIS: COUNTY UNKNOWN: *Hall* (BSNH). MENARD CO.: bark of trees, Athens, 1878, *Hall* (FM); on old trees, 1878, *Hall* (FM).

MINNESOTA: CLAY CO.: on shaded rocks, near Ulen, July 5, 1899, *Fink 287* (MIN).

IOWA: EMMET CO: on rock, Esterville, Oct. 1926, *Fink* (BPI).

ARKANSAS: GARLAND CO.: on oak tree, Little Rock Highway, 3 miles from Hot Springs, July 23, 1939, *Scully 1375* (MBG). NEWTON CO.: on bark of tree, wooded hillside, 11 miles south of Harrison, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG).

41. Parmelia sulphurosa (Tuck.) Fink, Lich. Fl. U. S., 328. 1935.

Parmelia tiliacea var. *sulphurosa* Tuck., Syn. N. Amer. Lich. 1: 57. 1882.

The type of the variety cited by Tuckerman was collected by A. H. Curtiss in Florida. This plant is now in the Tuckerman Herbarium at the Farlow Herbarium. Fink used the same collection as a type in the transfer of the variety to the rank of species.

Thallus 3–10 cm. diameter, closely adnate to bark of trees, lobes short and rounded, slightly imbricated; upper surface smooth or covered with yellow soredia; medulla always yellow; lower surface black with brown margins, numerous black rhizinae; apothecium sessile, 1–9 mm. diameter, concave, light brown, amphithecium smooth or sorediate; K, none, C, none, K + C, none, P, none.

Algal layer continuous, 16–20 μ thick; upper cortex 8–12 μ thick, matrix yellow; medulla of loosely interwoven, hyaline hyphae of small diameter; lower cortex 8–16 μ thick, with a black matrix; thickness of thallus 100–120 μ; thecium 40–48 μ thick; ascus clavate, spores 8, 3–4 × 6–8 μ; paraphyses branched and enlarged slightly at the tips.

Distribution: Florida to Louisiana.

FLORIDA: COUNTY UNKNOWN: 1878, *Curtiss* (Type collection) (T).
LOUISIANA: PLAQUEMINES CO.: Grand Bayou, July 17, 1885, *Langlois* (US).

IV. AMPHIGYMNIA

Parmelia subgenus **Euparmelia** sect. **IV. Amphigymnia** Zahlbr. apud Engler & Prantl, Nat. Pflanzenfam. I Teil, Abt. 1: 213. 1907.

Parmelia sect. *Amphigymnia* Wainio, Étude Lich. Brèsil **1**: 28. 1860.

Parmotrema Mass., Atti I. R. Ist. Veneto, III. 5: 248. 1860.

Zahlbruckner's type is *Parmelia caperata* (L.) Ach. Wainio selected *Parmelia perlata* (Huds.) Ach. as the type of his sec-

tion of the subgenus *Euparmelia*. Massalongo cites *Parmelia perforata* (Wulf.) Ach. as the type of *Parmotrema*.

Thallus either smooth or ciliate at the margins; lower surface with a heavy mat of rhizinae at the center; marginal rhizinae either absent or papillose; apothecia sessile or very short-stalked. The distribution of the section is world-wide in the warmer portions of the earth.

KEY TO SPECIES IN EUPARMELIA SECTION AMPHIGYMNIA

A. Margins always ciliate.
  B. Upper surface never with lobules or isidia.
    C. Closely adnate.
      D. Lower surface light.....50a. *perforata* var. *hypotropa*
      D. Lower surface dark.....50. *perforata*
    C. Loosely adnate.....46. *perlata*
  B. Always with lobules or isidia.
    C. Lobules always present on upper surface and amphithecium..51. *proboscidea*
    C. Isidia or coralloid branchlets always present.
      D. Thallus loosely adnate, orbicular in outline.....48. *crinita*
      D. Thallus closely adnate, never orbicular in outline.....
        .....46a. *perlata* var. *ciliata*
A. Margins never ciliate.
  B. Upper surface smooth.
    C. With marginal soredia.
      D. Soredia white.
        E. Soredia globose, confluent; K, reddish, C, none .....49. *cristifera*
        E. Soredia not globose, scattered, never confluent.
          F. Thallus light gray.
            G. K, yellow-green, C, yellow.....47. *cetrarioides*
            G. K, red-brown, C, none.....47a. *cetrarioides* var. *rubescens*
          F. Thallus yellowish; K, none, C, red.....44. *soredica*
      D. Soredia yellow; K, red, C, none.....45. *Herreana*
    C. Without marginal soredia.
      D. Thallus yellowish-green.
        E. Smooth below; K, none, C, none.....43. *praesignis*
        E. Reticulate below; K, red, C, intense red.....53. *latissima*
      D. Thallus dark green; K, none, C, none.....42b. *caperata* var. *subglauca*
  B. Upper surface with scattered soredia or isidia.
    C. With scattered soredia.
      D. K, yellow, C, none.....42. *caperata*
      D. K, none, C, none.....42a. *caperata* var. *incorrupta*
    C. With scattered isidia.....52. *tinctoria*

42. Parmelia caperata (L.) Ach., Meth. Lich. 216. 1803.

Lichen caperatus Linn., Sp. Pl. 1147. 1753.

Platisma caperatum Hoffm., Descr. & Adumbrat. Pl. Lich. **2**: 50. 1794.

The type of Linnaeus was from central Europe, and the plant is now in the Linnean Herbarium in London. Hoffmann's type is unknown but he cites Linnaeus' *Lichen caperatus* as synonymous with his *Platisma caperatum*. Acharius' type is in Helsinki, Finland.

Thallus 5–25 cm. diameter, adnate on trees, stones, buildings, and fences; upper surface wrinkled and often sorediate, lobes short, rounded, imbricated margins crenate and often slightly ascending, seldom with soredia; lower surface black at the center with light brown margins, rhizinae black and heavy at the center, very small and light-colored at the margins; apothecium rare, sessile, 2–15 mm. diameter, disk chestnut-brown, concave, amphithecium entire, often with coralloid branchlets, isidia, or soredia; K, yellow, C, none, K + C, none, P, red.

Algal layer continuous or discontinuous, 15–30 μ thick; upper cortex 15–18 μ thick, matrix yellow-brown, cells small; medulla of loosely interwoven hyphae, of one type, hyaline and of small diameter; lower cortex 12–20 μ thick, matrix black or dark brown; thallus 114–120 μ thick; thecium 80–100 μ thick; ascus clavate, spores 8, 12–16 × 16–20 μ; paraphyses branched.

Distribution: Ontario to Florida, west to Washington and California.

ONTARIO: on old fence rails, Ottawa, Apr. 26, 1891, *Macoun 79* (MIN,WIS, MBG); on trees, stumps, and fallen trees, Rainy Lake, Aug. 20, 1930, *Schmidt 9* (MBG); on trunks and old rails, Ottawa, Apr. 26, 1900, *Macoun 50* (MBG); on trees in cedar swamps, Emo, July 17, 1901, *Fink 646* (MIN); on rocks, Emo, July 20, 1901, *Fink 769* (MIN).

MAINE: WASHINGTON CO.: June 1929, *Markin* (WIS). KENNEBEC CO.: Albion, Mar. 23, 1922, *Parlin 3* (D). CUMBERLAND CO.: on rocks, Cumberland, Nov. 7, 1855, *Blake* (FM); Peaks Island, Aug. 31, 1893, *Curtis* (NYBG). COUNTY UNKNOWN: 1859, *DeLeashi* (FM); 1863, *Blake* (FM).

NEW HAMPSHIRE: COOS CO.: on rocks, Cherry Mountain, Aug. 8, 1895, *Harper & Harper* (FM). COUNTY UNKNOWN: Wiley Brook, *Faxon* (MBG).

VERMONT: WINDHAM CO.: on apple tree, Pike Hollow, Wardsboro, July 3, 1935, *Moore 1358* (MBG); Grout Pond, Stratton, July 4, 1935, *Moore* (MBG). ADDISON CO.: Monkton, May 6, 1879, *Faxon* (WIS); on *Pinus Strobus*, Chipman Hill, Middlebury, Apr. 13, 1913, *Dodge* (D). RUTLAND CO.: cedar tree in swamp, Brandon, elev. 475 ft., Feb. 26, 1921, *Dutton 1215* (FM); on rocks, elev. 600 ft., Brandon, Nov. 11, 1922, *Dutton* (MBG); on rock, Tadmer Hill, Pawlet, Apr. 14, 1923, *Dodge* (D); Chipman Lake, Tinmouth, June 1938, *Dodge* (D).

MASSACHUSETTS: ESSEX CO.: on rocks, Annisquam, Apr. 1, 1892, *Cummings 55b* (WIS,MBG). MIDDLESEX CO.: Concord, 1863, *Mann* (FM). NORFOLK CO.:

Wellesley, *Cummings 108* (NYBG); on juniper, Wellesley, May 4, 1892, *Cummings 55* (MBG); on *Juniperus communis*, Wellesley, Nov. 1895 and 1896, *Cummings 170* (FM). BRISTOL CO.: New Bedford, *Willey* (BSNH); on rocks and trunks, New Bedford, *Willey 35* (FM); New Bedford, *Willey 40* (MIN). WORCESTER CO.: on chestnut tree, near Haynes Reservoir, Leominster, Feb. 6, 1922, *Fassett* (D). PLYMOUTH CO.: Hingham, *Russell* (FM). COUNTY UNKNOWN: *Russell* (WIS).

NEW YORK: YATES CO.: Dundee, *Wright 22* (FM). ONONDAGA CO.: on fence, Syracuse, Nov. 20, 1886, *Underhill* (NYBG).

PENNSYLVANIA: LANCASTER CO.: on chestnut rails, Aug. 27, 1879, *Rothrock* (FM); on trees, Lancaster, Mar. 4, 1894, *Eby* (MBG); on rocks, Mountville, Sept. 15, 1892, *Eby* (MBG); on bark, Beartown, June 1895, *Eby* (MBG); on fence rails, Rheinholds, Mar. 11, 1893, *Eby* (MBG); on rocks, Smithville, May 16, 1894, *Eby* (MBG); on trees, Crow Hill, Mar. 17, 1894, *Eby* (MBG). ADAMS CO.: on tree, Rock Creek, Gettysburg, May 29, 1936, *Mrs. E. C. White 215* (US). FRANKLIN CO.: Charmian, elev. 1320 ft., May 29, 1936, *Mrs. E. C. White 205* (US). COUNTY UNKNOWN: Brand Creek, 1855, *Dr. Mi* (FM).

MARYLAND: MONTGOMERY CO.: rock outcrop, west knoll, Plummers Island, in the Potomac River, near Cabin John, Nov. 6, 1938, *Leonard 2789, 2763* (US, MBG); base of hickory tree, west knoll, Plummers Island, in the Potomac River, near Cabin John, Nov. 6, 1938, *Leonard 2788* (US,MBG); rock outcrop, west end Plummers Island, in the Potomac River, near Cabin John, Nov. 7, 1937, *Leonard 2666* (US,MBG); vertical surface cliff, east side of Cabin Hill, Plummers Island, in the Potomac River, Nov. 6, 1938, *Leonard 2823* (US,MBG); rock outcrop, west knoll, Plummers Island, in the Potomac River, Nov. 6, 1938, *Leonard 2796* (US). COUNTY UNKNOWN: on rocks, Sept. 21, 1902, *Maxon* (M).

VIRGINIA: HIGHLAND CO.: on white oak, Monterey, Sept. 1, 1935, *Darrow 983* (FM). SMYTH CO.: on Walker Mountain, elev. 3300 ft., June 13, 1892, *Leeming* (W). WASHINGTON CO.: on summit of White Top Mountain, May 28, 1892, *Small* (MBG,MIN). COUNTY INDEFINITE: Blue Ridge, southwest Virginia, elev. 5670 ft., May 28, 1892, *Small* (MIN).

NORTH CAROLINA: STOKES CO.: on exposed rocks, Moore's Spring, May 3, 1930, *Schallert* (WIS). COUNTY UNKNOWN: on bark of trees, Nissen Park, July 4, 1922, *Schallert 1285* (WIS).

FLORIDA: LAKE CO.: Eustis, June 16–30, 1895, *Nash* (MBG). ORANGE CO.: Sanford, May 1911, *Rapp* (BPI).

LOUISIANA: COUNTY UNKNOWN: on pickets, Jan. 3, 1894, *Langlois* (M).

OHIO: BELMONT CO.: on tree trunks, Apr. 30, 1938, *Wareham 933* (O). GEAUGA CO.: on trees, Oct. 9, 1937, *Wolfe 911* (O). MEIGS CO.: on rock, Apr. 5, 1936, *Wolfe 516* (O). ATHENS CO.: on rock in woods, Sept. 22, 1935, *Wolfe 258* (O). RICHLAND CO.: on bark of tree, Apr. 20, 1935, *Wareham 84* (O). HOCKING CO.: on tulip tree, Ash Cave, Oct. 13, 1935, *Wolfe 278* (O). JACKSON CO.: on north facing of cliff, Nov. 3, 1935, *Wolfe 322* (O). FAIRFIELD CO.: on face of cliff, Apr. 27, 1935, *Wolfe 99* (O). SCIOTO CO.: on oak, Mar. 22, 1936, *Wolfe 500* (O). DELAWARE CO.: on exposed root of white oak, Apr. 20, 1935, *Wolfe 6* (O). PICKAWAY CO.: on elm, May 5, 1935, *Wolfe 133* (O). PIKE CO.: on bark, Sept. 15, 1935, *Wolfe 207* (O). WYANDOTTE CO.: on white oak, May 29, 1935, *Wolfe 229* (O). UNION CO.: on trees near road, May 3, 1936, *Wolfe & Hartley 656* (O). ADAMS CO.: on cedar, Lynn, May 28, 1937, *Wolfe 850* (O). LOGAN CO.: on elm, May 3, 1931, *Wolfe & Hartley*

660 (O). CLINTON CO.: on oak, Mar. 18, 1936, *Wolfe & Hill 588* (O). BROWN CO.: on elm, Apr. 18, 1936, *Wolfe & Hill 583* (O). CHAMPAIGN CO.: willow tree along Storms Creek, home farm 1¼ miles east of Thackery, July 9, 1934, *Leonard 1722* (US,MBG). CLERMONT CO.: on tree, Apr. 18, 1936, *Wolfe & Hill 612* (O). WARREN CO.: on tree, Apr. 18, 1936, *Wolfe & Hill 602* (O). DARKE CO.: on trees, New Madison, Apr. 2, 1938, *Wallace 922* (O). PREBLE CO.: on granite, open woods, Eaton, Mar. 9, 1914, *Fink* (M). BUTLER CO.: on stone, Oxford, July 6, 1924, *Walters* (M).

MICHIGAN: KEWEENAW CO.: Isle Royale, Sept. 13, 1901, *Stuntz & Allen* (WIS). ALGER CO.: on cedar in swamp, Grand Marais, Aug. 2, 1902, *Fink* (M). MARQUETTE CO.: on trees, Mud Lake Bog, Whitman Lake, June 17, 1930, *Hedrick* (M).

INDIANA: TIPPECANOE CO.: on rocks in open wood near Lafayette, Aug. 31, 1917, *Fink & Tuson* (D). FOUNTAIN CO.: on sandstone rock in the Bear Creek Canyon just south of Fountain, Apr. 22, 1917, *Deam 22.252* (BPI).

KENTUCKY: ROCKCASTLE CO.: bark of trees, open pine woods near Rockcastle River east of Livingston, Aug. 18, 1937, *Hubricht B253* (MBG). BALLARD CO.: Kevil, Apr. 26, 1936, *Fassett* (WIS).

TENNESSEE: HAMILTON CO.: on rocks, Lookout Mountain, *Calkins 7* (MIN).

WISCONSIN: FOND DU LAC CO.: on granitic rocks in pasture at north end of Wolf Lake, July 17, 1938, *Schinners* (WIS); bark of trees, edge of tamarack bog, northeast end of Wolf Lake, July 17, 1938, *Schinners* (WIS). DODGE CO.: on rocks, northeast of Kekoskee, May 1936, *J. Thomson* (WIS). WAUSHARA CO.: 2 miles east of Plainfield, Oct. 13, 1935, *J. Thomson* (WIS); sand plains, abandoned 7 years, south of Plainfield, Oct. 13, 1935, *J. Thomson* (WIS). MARQUETTE CO.: in *Larix* swamp, 12 miles east of Westfield, Oct. 13, 1935, *J. Thomson* (WIS). DANE CO.: common on trees and fences, Madison, May 10, 1893, *Head & Buell* (WIS). VILAS CO.: valley of Wisconsin River near Lac Vieux Desert, Summer, 1893, *Cheney* (WIS). SAUK CO.: on bark, Devils Lake, Oct. 27, 1935, *J. Thomson* (WIS). JUNEAU CO.: Apr. 1936, *J. Thomson* (WIS). MONROE CO.: 9 miles west of Tomah, Nov. 14, 1935, *J. Thomson* (WIS). GRANT CO.: bluffs of Wisconsin River, Potosi, Oct. 6, 1935; *J. Thomson* (WIS). LA CROSSE CO.: on trees, La Crosse, Dec. 1894, *Pammel* (MBG). WASHBURN CO.: on bark of dead, white birch tree, also on moss of forest floor near Spooner, Apr. 1932, *Flint* (MONT).

ILLINOIS: COOK CO.: on oaks, *Calkins* (FM). JACKSON CO.: on sandstone boulders near Bat Cave, 5 miles southwest of Pomona, Apr. 14, 1940, *Hubricht B1734* (MBG). MENARD CO.: on old trees, 1878, *Hall* (FM); *Hall 8* (FM); on rock, Athens, May 16, 1879, *Hall* (FM). ADAMS CO.: on boulders, Quincy, May 30, 1898, *Harper & Harper 34* (FM).

MINNESOTA: COOK CO.: on rocks, Grand Portage Island, June 23, 1897, *Fink 916* (MIN); on cedar in swamp, Grand Marais, Aug. 2, 1902, *Fink 5284* (MIN). LAKE CO.: Two Harbors, Aug. 25, 1893, *Harper* (FM); on trees, Beaver Bay, July 14, 1897, *Fink 728* (MIN); on trees, Snowbank Lake, July 19, 1897, *Fink 804* (MIN); on trees, Snowbank Lake area, July 24, 1897, *Fink 916* (MIN). ST. LOUIS CO.: on trunk of *Fraxinus americana*, Vermilion Lake, July 19, 1886, *Arthur, Bailey Jr. & Holway A25* (MIN); on rocks, Tower, Aug. 24, 1901, *Fink 1718* (MIN). CARLTON CO.: on trees, Tafte, Carlton Peak, July 10, 1897, *Fink* (MIN). KOOCHICHING CO.: on earth, Gunflint, June 30, 1897, *Fink 254A* (MIN); on rocks, Koochiching, July 31, 1901, *Fink 1059* (MIN). AITKIN CO.: on rocks, Palisades, July 15, 1897, *Fink 768* (MIN); on *Pinus Strobus*, Mille Lacs Indian Reservation, June 1892, *Sheldon S2636* (MIN). HENNEPIN CO.: on bark, Minne-

apolis, Apr. 1891, *Sheldon S4108* (MIN). BLUE EARTH CO.: on trees and rocks, Mankato, July 23, 1899, *Fink 53* (MIN); on trees, Mankato, June 27, 1899, *Fink 153* (MIN). LAKE OF THE WOODS CO.: on bark, Lake of the Woods, July 1896, *Millan 4* (MIN). BELTRAMI CO.: on trees, Red Lake, July 26, 1900, *Fink 898* (MIN); on tamarack in swamp, Bemidji, July 7, 1900, *Fink 527* (MIN); on pines, Bemidji, July 11, 1900, *Fink 659* (MIN); on rocks along lake, Red Lake, Aug. 1, 1900, *Fink 1033* (MIN); on old trees, Beaudette, June 19, 1901, *Fink 20* (MIN). MEEKER CO.: on bark of trees, Litchfield, June 1892, *Frost F115d* (MIN). OTTERTAIL CO.: on trees, Battle Lake, June 19, 1900, *Fink 26* (MIN); on tamarack in swamp, Henning, June 25, 1900, *Fink 195* (MIN); on tamarack in swamp, Henning, July 2, 1900, *Fink 409* (MIN). ROSEAU CO.: on trees, Warroad, June 26, 1901, *Fink 182* (MIN). BECKER CO.: on trees, Oak Island, July 11, 1901, *Fink 524* (MIN). PENNINGTON CO.: on trees, Thief River Falls, July 20, 1900, *Fink 832* (MIN); on trees, Thief River Falls, July 20, 1900, *Fink 841* (MIN). POLK CO.: Red River, May 1857, *Fink* (MIN). CLAY CO.: on rocks near Ulen, July 5, 1899, *Fink 285* (MIN). PIPESTONE CO.: on rocks, Pipestone, 1892, *Manzel* (MIN). COUNTY INDEFINITE: on trees, Misquah Hills, July 3, 1897, *Fink 403* (MIN); on twigs, Shoal Lake Island, July 1894, *Millan & Sheldon 1040* (MIN).

IOWA: MUSCATINE CO.: on rocks, Wild Oat Glen, Nov. 15, 1897, *Savage & Shink* (IA). HENRY CO.: on bark, Jan. 1, 1898, *Savage* (IA). JOHNSON CO.: on apple tree, Mar. 20, 1896, *Fitzpatrick & Fitzpatrick* (FM). FAYETTE CO.: on trees and fences, 1892, *Fink* (MIN,MBG). POWESHIEK CO.: on sandstone, Grinnell, Mar. 13, 1904, *Fink 246* (FM).

MISSOURI: DUNKLIN CO.: on tree, Sept. 28, 1897, *Bertig* (MBG). STE. GENEVIEVE CO.: on soil over rocks, River Aux Vases, Apr. 10, 1932, *Moore* (MBG). WAYNE CO.: on tree, Clark Mountain, Mar. 1898, *C. Russell* (MBG). ST. LOUIS CO.: on trees, Valley Park, May 1897, *C. Russell* (MBG); on bark of tree, Ranken Estate, Valley Park, Apr. 20, 1939, *Berry* (MBG); on trees, Allenton, Apr. 15, 1905, *Schulte & Jones* (MBG). ST. FRANCOIS CO.: on rocks, open woods, Koester, June 10, 1939, *Hubricht B1508* (MBG); bark of tree, Pickle Springs, May 21, 1938, *Berry* (MBG); on sandstone ledges in woods, Pickle Springs, May 21, 1938, *Berry* (MBG). WASHINGTON CO.: rock-covered hillside, near Antonio, Oct. 29, 1939, *Berry* (MBG). IRON CO.: full sun to semi-shade, Royal Gorge, 3 miles east of Arcadia, Nov. 18, 1939, *Hubricht B1722* (MBG); near Arcadia, May 1925, *Greenman* (MBG). LINCOLN CO.: July 1897, *Freuring* (MBG). FRANKLIN CO.: sandstone ledge in sunny glade, Missouri Botanical Garden Arboretum, Gray Summit, May 2, 1938, *Berry* (MBG). MONTGOMERY CO.: bark of tree, Montgomery City, Nov. 23, 1930, *Drouet* (MBG). BOONE CO.: on decayed stumps, wooded hillside, 9 miles east of Columbia, Oct. 5, 1935, *Berry 240* (MBG). PULASKI CO.: on chert, open woods 2 miles north of Hanna, Oct. 8, 1939, *Hubricht B1709* (MBG). GREENE CO.: on bark of tree, rocky wooded bank of James River, 8 miles south of Springfield, Apr. 7, 1939, *Dodge, Berry & Johnson* (MBG).

ARKANSAS: BOONE CO.: on twigs and bark, rocky wooded bluff above dry creek bed, Bear Creek Spring, 0.5 mile north of Francis, Apr. 7, 1939, *Dodge, Berry & Johnson* (MBG). NEWTON CO.: on bark of tree, high bluff and long steep wooded hillside, Lookout Point, 7 miles south of Jasper, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG); bark of tree, steep dry wooded bluff with rocky flat at top, 1 mile south of Ponca, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG); wooded hillside, 11 miles south of Harrison, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG).

GARLAND CO.: on rocks on ridge, water-works, Hot Springs, July 19, 1939, *Scully 1370* (MBG). WHITE CO.: on bark of tree, near Judsonia, Dec. 28, 1938, *E. Anderson* (MBG). LOGAN CO.: open woods, 0.6 mile east of the Lodge, summit of Magazine Mountain, May 4, 1940, *Hubricht B1905* (MBG).

SOUTH DAKOTA: PENNINGTON CO.: on bark of trees, Rapid City, Apr. 27, 1927, *Lee* (F).

OKLAHOMA: MURRAY CO.: on dead cedar, Prices Falls, Apr. 30, 1926, *Stratton* (M).

TEXAS: DENTON CO.: on oaks, 3 miles southwest of Denton, Feb. 1935, *Bussard* (MBG). BREWSTER CO.: practically covering the trunks of pines on the north side of Mount Emory, Chisos Mountains, July 2, 1937, *Warnock* (MBG).

COLORADO: EL PASO CO.: on log of *Pseudotsuga taxifolia,* elev. 8300 ft., Pikes Peak, July 1919, *I. M. Johnston* (F). LA PLATTE CO.: on dead wood, 14 miles south of Durango, elev. 6700 ft., Aug. 16, 1920, *Reeside Jr.* (BPI). WELD CO.: over siliceous rocks, South St. Vrain Canyon, elev. 7200 ft., Oct. 7, 1936, *Kiener 4526* (MBG).

NEW MEXICO: COLFAX CO.: on moist igneous rocks, vicinity of Ute Park, elev. 2200–2900 m., Aug. 23, 1916, *Standley* (F). SAN MIGUEL CO.: on trees, Las Vegas, 1926, *Bro. Anect* (M). TORRANCE CO.: Manzano Mountains, July 28, 1932, *Jones* (M).

ARIZONA: COCHISE CO.: Carr Peak, Huachuca Mountains, July 16, 1909, *Goodding* (F).

WASHINGTON: WALLA WALLA CO.: on bluffs of columnar lava, along the Columbia River, gorge below Wallula, elev. 200 ft., *Foster* (F).

OREGON: COUNTY INDEFINITE: in forest, Nov. 10, 1894, *Lloyd* (NYBG).

CALIFORNIA: SAN FRANCISCO CO.: on rocks and twigs, San Francisco, near Golden Gate, elev. 50 ft., July 1904, *Herre* (LSU,MIN,MBG). SANTA CLARA CO.: on trees, Black Mountain, Santa Cruz Mountains, June 16, 1903, *Herre* (M,LSU,MBG). SANTA CRUZ CO.: Santa Cruz, *C. S. Anderson* (BSNH). MONTEREY CO.: on shaded granite, cypress headland, Point Lobos Reserve, July 11, 1936, *Wheeler* (MBG). LOS ANGELES CO.: large oak, Bull Rush Canyon, Santa Catalina Island, *Knopf* (F). SAN DIEGO CO.: shade to semi-shade, forming thick mats on trunks of oak, pine and cypress, Alpine, Jan. 1933, *Cota* (MBG).

42a. Parmelia caperata var. **incorrupta** (Moore) Berry, n. comb.

Parmelia incorrupta Moore, Ann. Mo. Bot. Gard. **19**: 503. 1932.

Moore's type was collected in the Guadaloupe Mountains of Texas, and is now in the Missouri Botanical Garden Herbarium, No. 1020340.

This plant differs from the species only in that it gives no color reaction with KOH, and this, in the opinion of the writer, does not constitute a specific difference.

Distribution: found only in Texas.

TEXAS: CULBERSON CO.: on bark of *Pinus flexilis*, ridge above McKittrick Canyon, elev. 2300 m., Guadaloupe Mountains, July 17, 1931, *Moore & Steyermark 3490* (Type collection) (MBG); on *Quercus*, slopes of Emory Peak, elev. 2000 m., June 22, 1931, *Moore & Steyermark 3220* (MBG). EL PASO CO.: Fort Bliss, *Mrs. Jos. Clemens* (MBG).

42b. Parmelia caperata var. **subglauca** (Gasilien) Nyl., Lich. Envir. Paris, 35. 1896.

Parmelia subglauca Gasilien, Jour. de Bot. (Morot) **8**: 126. 1894.

The type of Gasilien was from Saint Omer, France. The type is unknown, but a co-type collection is in Nylander's Herbarium at Helsinki, Finland. Nylander did not change the type in his transfer of the species to a variety.

This plant differs from the species in its small size, glossy upper surface, the abundance of the apothecia, and in the absence of any reaction with KOH.

Distribution: found only in Texas.

TEXAS: NUECES CO.: on trees, vicinity of Corpus Christi, Mar. 1894, *Heller 197, 260* (MIN,MBG,WIS,FM). GILLESPIE CO.: Big Branch, *Jermy* (MBG). BEXAR CO.: San Antonio, *Langlois* (US); mesquite woods, 18 miles east of San Antonio, May 17, 1940, *Hubricht 1927* (MBG); mesquite woods, 1.5 miles southeast of junction of Jolly Lane and Atkins-Elmendorf Lane, 18 miles east of San Antonio, May 17, 1940, *Hubricht B1891* (MBG). HARRIS CO.: Houston, *Hall* (FM).

43. Parmelia praesignis Nyl., Bull. Soc. Linn. Norm. II, **6**: 270. 1872.

The type was collected in the Valley of Mexico, and is Bourgeau, No. 1361, in the Paris Museum.

Thallus large, 10–20 cm. diameter, loosely adnate to bark of trees; upper surface slightly wrinkled, cortex often broken by irregular cracks or round holes; lobes wide, short, round, and slightly dissected, margins flat, smooth and slightly brownish in color; lower surface brown at the margins, black at the center, with a few black rhizinae at the points of contact with the substratum; apothecium 1–5 mm. diameter, sessile, disk deeply concave, margins of amphithecium thick, cortex often missing in irregular areas; K, upper cortex yellowish-brown, which soon disappears, medulla none, C, none, K + C, none, P, medulla gray.

Algal layer continuous, 12–15 μ thick; upper cortex 16–20 μ thick, matrix light brown; medulla of loosely interwoven, large, hyaline hyphae; lower cortex 35–40 μ thick, matrix black; thallus 243–260 μ thick; thecium 100–125 μ thick; ascus clavate, spores 8, 6–8 × 14–16 μ; paraphyses branched.

Distribution: Arizona and New Mexico.

NEW MEXICO: CATRON CO.: shade, 11 miles north of Pie Town, June 9, 1938, *Hubricht B1062* (MBG).

ARIZONA: PIMA CO.: on trees, near Tucson, *Fink 12974* (M).

This plant is widely distributed in Mexico and Central America.

44. Parmelia soredica Nyl., Flora **68**: 605. 1885.

The type was collected in Saskatchewan, Canada, and is in Nylander's Herbarium, Helsinki, Finland. The collector is unknown.

Thallus large, adnate to substratum, yellowish-green to yellowish-brown, margins and upper surface with many white soredia which often become large and are easily detached; lobes wide, round, and sparingly branched, margins slightly ascending, wrinkled and somewhat inflated; lower surface brown at the margin, black at the center with very few scattered rhizinae; apothecium rare, 3–12 mm. diameter, sessile, disk concave, chestnut-brown, amphithecium sorediate; K, none, C, medulla red, K + C, none, P, none.

Algal layer continuous, 20–30 μ thick; upper cortex 20–24 μ thick, matrix yellow, cells of cortex very small; medulla of loosely interwoven, hyaline hyphae of one type; lower cortex 20–30 μ thick, matrix black; thallus 320–342 μ thick; thecium 38–40 μ thick, ascus clavate, spores 8, 6–8 × 12–16 μ; paraphyses branched and slightly enlarged at the tip.

Distribution: British Columbia to New Mexico and California.

NEW MEXICO: SOCORRO CO.: shade, 4 miles west of Magdalene, June 9, 1938, *Hubricht B1046* (MBG); shade, San Andres Mountains, Rhodes Pass, 47 miles west of Tularosa, June 6, 1938, *Hubricht B992* (MBG).

BRITISH COLUMBIA: on rocks, 2000 ft. elev., *Macoun* (FM).

CALIFORNIA: CONTRA COSTA CO.: on *Pinus ponderosa*, Mount Diablo, May 18, 1932, *Herre* (LSU); on *Quercus sp.*, Mount Diablo, May 19, 1932, *Herre* (LSU).

ALAMEDA CO.: Oakland Hills, elev. 1000 ft., Mar. 14, 1935, *Herre* (LSU). SANTA CLARA CO.: on *Quercus lobata*, Stanford University, elev. 75 ft., Feb. 4, 1903, *Herre* (MBG,MIN); on roof of house, Mayfield, elev. 35 ft., Santa Cruz Peninsula, Apr. 1, 1904, *Herre* (MBG,MIN); on *Quercus lobata*, Los Gatos, Mar. 1, 1905, *Herre* (LSU); on twigs, Searsville Ridge near Stanford University, Mar. 3, 1936, *Herre* (LSU); on bark of *Catalpa*, campus of Stanford University, Nov. 14, 1939, *Herre* (LSU). SAN BENITO CO.: red oak, near Aromas, July 23, 1939, *Herre* (LSU); on trees, Searsville, elev. 318 ft., July 4, 1903, *Herre* (MBG,MIN); bark of *Ficus*, Goff ranch, Kenwood, Jan. 27, 1936, *Goff 26* (LSU). LOS ANGELES CO.: Santa Monica Range, Feb. 1895, *Hasse* (FM). SONOMA CO.: 1893, *Bioletto* (LSU). MARIN CO.: bark of tree, Mill Valley, Nov. 20, 1930, *Herre* (LSU). SAN MATEO CO.: Kings Mountain, Santa Cruz Mountains, elev. 1900 ft., Spring 1930, *Herre* (LSU); on live oak, elev. 2000 ft., Santa Cruz Mountains, Aug. 12, 1938, *Herre* (LSU); on *Quercus agrifolia*, hills near Woodside, elev. 800 ft., Nov. 18, 1939, *Herre* (LSU); on oaks, Santa Cruz Mountains, 12 miles west of Stanford University, elev. 1500 ft., Apr. 26, 1933, *Herre* (LSU).

45. Parmelia Herreana Zahl., Cat. Lich. Univ. **6**: 239. 1930.
Parmelia perlata var. *flavicans* Tuck., Lich. Calif., 13. 1866.
Parmelia flavicans Tuck., Syn. N. Amer. Lich. **1**: 55. 1882 (non Ach.).

Tuckerman's type was from Oakland, California, and is now in his herbarium in the Farlow. The specific name *flavicans* is non-valid because of its prior use by Acharius. Zahlbruckner applied a valid name to the type.

Thallus large, 8–15 cm. diameter, loosely adnate to bark of trees and stones; upper surface smooth, greenish-yellow or pale yellowish, with yellow soredia, lobes wide or narrow with crenate and sorediate margins; lower surface black with a chestnut-brown margin, scattered black rhizinae at the points where the thallus touches the substratum; apothecium 3–6 mm. diameter, disk chestnut-brown, slightly concave, amphithecium often sorediate; K, red, C, none, K + C, red, P, none.

Algal layer continuous, 22–24 μ thick, or of thinly scattered gonidia 20–22 μ in diameter; upper cortex 40–60 μ thick; medulla of loosely interwoven hyphae of one type; lower cortex 20–30 μ thick, matrix brown or black; thallus 120–130 μ thick; thecium 88–108 μ thick; ascus clavate, spores 8, 6–8 × 16–20 μ; paraphyses branched and enlarged at the tips.

Distribution: Idaho to Arizona, west to California.

IDAHO: NEZ PERCES CO.: Lake Waha, elev. 2000–3500 ft., June 29, 1896, *Heller & Heller* (MBG).

ARIZONA: YAVAPAI CO.: Prescott, July 1898, *Kanza* (NYBG).

CALIFORNIA: ALAMEDA CO.: on bark of trees and among mosses, deep canyon, Oakland, *Bolander 70* (Type collection) (T). SANTA CLARA CO.: sandstone, elev. 200–300 ft., Pilarcitos Creek Canyon, Aug. 14, 1903, *Herre 212* (NYBG); on mossy sandstone, foothills near Stanford University, elev. 300 ft., Aug. 9, 1936, *Herre* (LSU); sandstone covered with moss, hills near Stanford University, elev. 400 ft., Mar. 22, 1903, *Herre* (MBG). SAN BENITO CO.: on sandstone, big rock on Pinedale cutoff, Mar. 31, 1935, *Herre* (LSU). LOS ANGELES CO.: on mossy bank, elev. 2200 ft., mountains north of Claremont, Oct. 22, 1816, *I. M. Johnston 3039* (LSU). SONOMA CO.: on sandstone, stony point near Searsville, July 9, 1903, *Herre* (NYBG, MIN,MBG). RIVERSIDE CO.: on wet moss, barranca switch back, of highway, San Jacinto Mountains, elev. 4000 ft., Feb. 23, 1935, *Reed* (MBG). SAN DIEGO CO.: San Diego, 1933, *Cota* (MBG).

46. Parmelia perlata (Huds.) Ach., Meth. Lich. 216. 1803.

Lichen perlatus Huds., Fl. Anglica, 448. 1762.

Lobaria perlata Hoffm., Deutschl. Fl. **2**: 148. 1795.

Hudson's type was collected in England, its present location being unknown. Acharius cites Hudson's plant as synonymous with his, and also cites as a synonyn, Wulfen apud Jacquin, 'Collectanea' **4**: *t. 10.* 1790.

Thallus 5–20 cm. diameter, loosely adnate; upper surface smooth except at the margins where it is commonly sorediate, margins wavy and somewhat dissected dichotomously at the tips of the lobes, slightly ciliate; lower surface black with scattered black rhizinae which often give the appearance of black cilia, margins brown; apothecium rare, sessile or very short-pedicellate, 4–12 mm. diameter, disk chestnut-brown, concave, amphithecium entire and never sorediate; K, yellow then red, C, none, K + C, none, P, none.

Algal layer continuous, 15–20 μ thick; upper cortex 12–16 μ thick, yellow-brown; medulla loosely interwoven, hyphae of one type, hyaline and of small diameter; lower cortex 20–24 μ thick, matrix dark brown or black; thickness of thallus 132–140 μ; thecium 88–94 μ thick; ascus clavate, spores 8, 8–10 × 10–12 μ; paraphyses branched and enlarged at the tip.

Distribution: Quebec to Florida, west to British Columbia and California.

QUEBEC: on twigs, woods along River Ste. Anne des Monts, July 22, 1923, *Collins & Dodge* (F).

MAINE: WALDO CO.: on boulder, Freedom, Sept. 24, 1922, *Parlin* (F).

NEW HAMPSHIRE: COOS CO.: White Mountains, 1885, *Farlow 415* (F). GRAFTON CO.: on rocks, North Woodstock, Franconia Mountains, July 1891, *Cummings* (F).

VERMONT: WINDSOR CO.: exposed ledges, Rochester, *Dutton* (F). RUTLAND CO.: on *Acer*, Pawlet, Aug. 1913, *Dodge* (D).

MASSACHUSETTS: WORCESTER CO.: on rocks, Lunenburg, 1883, *Sargent 416* (F).

PENNSYLVANIA: LANCASTER CO.: Welsh Mountain, Feb. 27, 1892, *Small* (MIN).

VIRGINIA: SMYTH CO.: along Necks Creek, June 4, 1892, *Leeming* (NYBG).

NORTH CAROLINA: HENDERSON CO.: on bark of tree, Flat Rock, *Schallert 1939* (WIS). FORSYTH CO.: on bark of tree, Bennetts Rock, Apr. 10, 1936, *Schallert* (MBG). HAYWOOD CO.: on bark of tree, Balsam Mountains, Sept. 8, 1922, *Schallert 6753* (FM); Eagle Nest, elev. 4700 ft., Aug. 29, 1902, *Curtis* (F); vicinity of Eagle Nest near Waynesville, elev. 900–1500 m., *Standley* (D). SWAIN CO.: open woods, 3 miles south of Smokemont, Aug. 27, 1937, *Hubricht B583* (MBG).

SOUTH CAROLINA: AIKEN CO.: Aiken, *Ravenel* (F). COUNTY UNKNOWN: on twigs, sand dunes, Pawleys Island, Aug. 3, 1936, *Schallert* (MBG).

FLORIDA: ORANGE CO.: on palmetto logs, Sanford, Mar. 1906, *Rapp VII* (F); on *Myrica*, in swamp, Sanford, *Rapp* (BPI). DUVAL CO.: on *Taxodium*, Jacksonville, 1892, *Calkins* (F). LAKE CO.: on bark of trees, Eustis, May 28 to June 15, 1895, *Nash 1836* (MIN,WIS). MARION CO.: Ocala, Jan. 29, 1891, *Underwood* (F). ESCAMBIA CO.: on oak bark, Pensacola, Dec. 1937, *Fassett* (WIS).

ALABAMA: MARSHALL CO.: open woods, 3.2 miles north of Boaz, July 21, 1939, *Hubricht B1548* (MBG).

LOUISIANA: ACADIA CO.: on trunk of trees, Sept. 17, 1894, *Langlois 997* (D).

OHIO: FRANKLIN CO.: Columbus, July 12, 1892, *Bogue L84* (O); Georgesville, July 15, 1892, *Bogue L65* (O). CLINTON CO.: New Antioch, Jan. 16, 1901, *Vandemark* (O).

MICHIGAN: OAKLAND CO.: on dead cedar, Thomasville, Aug. 26, 1902, *Fink* (F). KEWEENAW CO.: on rock face at tip of mat of spruce needles in shade, Tobins Harbor, July 14, 1930, *Lowe* (F).

KENTUCKY: KNOX CO.: open woods, 1.4 miles north of Jarvis Store, Aug. 19, 1937, *Hubricht B308* (MBG). LAUREL CO.: deep, wet woods, 8.4 miles north of East Bernstadt, Aug. 18, 1937, *Hubricht B266* (MBG).

TENNESSEE: HAMILTON CO.: on pine trees and rocks, Lookout Mountain, *Calkins 283* (MIN). CARTER CO.: Roan Mountain, *Thaxter* (F). SEVIER CO.: edge of woods, 2.3 miles north of Gatlinburg, Aug. 25, 1937, *Hubricht B454* (MBG). CLAIBORNE CO.: open woods near mouth of Indian Creek, Aug. 21, 1937, *Hubricht B366* (MBG).

ILLINOIS: MENARD CO.: Athens, *Hall* (WIS).

MINNESOTA: LAKE CO.: on rocks, Snowbank Lake, June 26, 1897, *Fink* (F). CARLTON CO.: on trees, Tafte, Carlton Peak, July 10, 1897, *Fink 527* (MIN).

IOWA: CLAYTON CO.: on trees, Sept. 1894, *Fink* (WIS).

MISSOURI: ST. FRANCOIS CO.: on trees, Pickle Springs, May 21, 1938, *Berry 1341* (MBG); on sandstone ledge, Pickle Springs, May 21, 1938, *Berry 1338* (MBG). GREENE CO.: bark of tree, rocky wooded bank of James River, 8 miles south of Springfield, Apr. 7, 1939, *Dodge, Berry & Johnson* (MBG).

ARKANSAS: NEWTON CO.: on bark of tree, steep dry wooded bluff with rocky flat top, 1 mile south of Ponca, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG); high bluff and long steep wooded hillside, Lookout Point, 7 miles south of Jasper, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG); moist woods on gentle slope near

falls, 11 miles south of Harrison, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG). SEARCY CO.: open wooded hillside, 4 miles west of Marshall, *Dodge, Berry & Johnson* (MBG). BOONE CO.: rocky wooded bluff, above dry creek bed, Bear Creek Spring, 0.5 mile north of Francis, Apr. 7, 1939, *Dodge, Berry & Johnson* (MBG).

TEXAS: HARRIS CO.: on oak, Houston, Jan. 7, 1917, *Fisher* (F).

BRITISH COLUMBIA: on trees, west coast of Vancouver Island, June 18, 1906, *Macoun* (F).

WASHINGTON: SAN JUAN CO.: on log lodge, Olga, July 16, 1906, *Fink 344* (M).

CALIFORNIA: MONTEREY CO.: cypress headland, Point Lobos Reserve, elev. 75 ft., July 11, 1936, *Wheeler* (MBG). LOS ANGELES CO.: on live oak, divide at head of Banning's Canyon, Santa Catalina Island, Apr. 24, 1921, *Knopf* (F). COUNTY INDEFINITE: on roof of an old house on sea beach near Pillar Point, elev. 10 ft., Aug. 14, 1903, *Herre* (LSU,F).

LOCAL AND FOREIGN EXSICCATAE EXAMINED: Cum. I *8;* Elenk. *52 a-c;* Flag. Lich. Fr.-C. *16;* E. Fries, *335;* Funck, I *661;* Hav. *325;* Johns. *23;* Larb. Herb. *291;* Leight. *76;* Lojk. Univ. *111;* Malbr. *65;* Mig. *90;* Oliv. *9;* Rab. *912;* Rab. Cent. *22;* Roum. *38;* Salw. *148;* Schaer. *360;* Spruce, *127;* Tuck. *15;* Wain. *538b;* Welw. *75, 77.*

46a. Parmelia perlata var. **ciliata** Duby, Bot. Gallic. **2**: 601. 1830.

Lobaria perlata var. *ciliata* DC. apud Lam. & DC., Fl. Fr. ed. 3, **2**: 403. 1815.

Parmelia submarginalis Eaton, Man. Bot. N. Amer. ed. 5, 316. 1836 (non Ach.).

Parmelia ciliata Nyl., Flora **61**: 247. 1878.

DeCandolle used as a type of the variety a plant collected in Switzerland, which is now in his herbarium in Geneva, Switzerland. Duby cites DeCandolle in his transfer of the variety to the genus *Parmelia,* but gives no reference to the actual existence of a type. The plants he studied were from eastern France. Nylander's herbarium in Helsinki, Finland, contains a collection designated *Parmelia ciliata* which may be the type of his species.

There is a collection in Tuckerman's herbarium designated *Parmelia submarginalis* which is evidently co-type with Eaton's type in Kew. This plant is *Parmelia perlata* var. *ciliata.* In his 'Cat. Lich. Univ.' **6**: 244. 1930, Zahlbruckner cites *Parmelia Michauxiana* as superseding *Parmelia submarginalis. Parmelia Michauxiana* Zahl. is non-valid because of prior use by Acharius (Lichenogr. Univ. 492. 1810).

The variety is the same as the species except that the mar-

gins of the variety are sparingly beset with strong black cilia and occasionally there are coralloid branchlets and cilia arising from the upper surface of the thallus. The chemical reaction and internal morphology are the same as those of the species.

Distribution: Tennessee to Minnesota.

TENNESSEE: HAMILTON CO.: on rocks and trees, Lookout Mountain, *Calkins 12* (MBG).

MINNESOTA: CARLTON CO.: on rocks, Kettle Falls, Aug. 15, 1901, *Fink 1496* (MIN); on cedar, Thomasville, Aug. 25, 1902, *Fink 5411* (MIN).

FOREIGN EXSICCATAE EXAMINED: Malbr. *315;* Cromb. *30;* Hepp. Zür. *41;* Larb. Caes. *17;* Larb. Herb. *86.*

47. Parmelia cetrarioides Del. apud Duby, Bot. Gallic. **2**: 601. 1830.

Parmelia olivaria f. *cetrarioides* Merrill, Bryol. **11**: 95. 1908.

Delise's type was from northern France, and is now in his herbarium in Strasbourg. Merrill's type was collected in southern Canada by J. Macoun and is in the Farlow Herbarium.

Thallus large, 8–20 cm. diameter, loosely adnate; upper surface somewhat wrinkled, cortex often cracked or broken, exposing a white medulla, lobes short, wide, round, greenish-gray to greenish-brown, margins crenulate, slightly raised, without cilia, occasionally with scattered soredia; lower surface black with brown margins, few small black rhizinae at points of contact with the substratum; apothecia rare, 2–10 mm. diameter, disks concave or flat, chestnut-brown, amphithecia thin, smooth, only slightly dissected; K, cortex and medulla generally yellow-green; C, medulla yellow, K + C, yellow, P, red-brown.

Algal layer continuous, 28–36 μ thick; upper cortex 16–20 μ thick; medulla of loosely interwoven hyphae of large diameter; lower cortex 32–36 μ thick; thallus 180–200 μ thick; thecium 48–60 μ; ascus clavate, spores 8, 6–8 × 12–16 μ; paraphyses branched.

Distribution: Nova Scotia to Florida, west to California.

NOVA SCOTIA: CUMBERLAND CO.: on trees, Truro, May 10, 1891, *Macoun* (Type of *P. olivaria* f. *cetrarioides)* (F). COUNTY UNKNOWN: *Rothrock* (FM).

QUEBEC: on rock, wet when collected, Ste. Anne, Apr. 27, 1935, *Lepage 200* (D); adherent to dry rock, Ste. Anne, May 2, 1935, *Lepage 140* (D); on mossy rocks, Ste. Anne, May 15, 1935, *Lepage 489* (D).

ONTARIO: on large trunks in woods, Ottawa, May 15, 1891, *Macoun* (MBG); on trees, Goulais Point, Aug. 4, 1869, *Macoun* (MBG); on trees in a swamp, Beechwood, Apr. 27, 1892, *Macoun* (MIN).

MAINE: KNOX CO.: on trunks of various trees, Rockland, Sept. 28, 1909, *Merrill 99* (MIN).

NEW HAMPSHIRE: COOS CO.: on rocks, Cherry Mountain, Aug. 8, 1895, *Harper & Harper* (FM); base of Mount Washington, Aug. 6, 1895, *Harper & Harper 47* (FM); near Gate of Notch, June 1882, *Faxon* (MBG,WIS). GRAFTON CO.: on rocks, Franconia Mountains, July 1891, *Cummings* (MBG); on rocks, North Woodstock, Franconia Mountains, July 1891, *Cummings 8* (WIS). BELKNAP CO.: Gilmanton, 1863, *Hall 30* (FM). HILLSBORO CO.: *Lapham* (WIS). CHESHIRE CO.: on rocks, Fitzwilliam, Aug. 1850, *Russell* (FM).

VERMONT: RUTLAND CO.: exposed ledges, Mount Pico, elev. 2500 ft., May 12, 1911, *Dutton* (WIS); Todmer area, Pawlet, June 26, 1913, *Dodge* (D); bare ledges, region of the Silver Mine, Birch Hill, Brandon, July 3, 1920, *Dutton* (MBG).

MASSACHUSETTS: MIDDLESEX CO.: on rocks, New Bedford, *Willey 34* (MIN).

NEW YORK: YATES CO.: Penn Yan, *Buckley* (MBG).

PENNSYLVANIA: PIKE CO.: Matamoras, Sept. 24, 1886, *Schneider* (MBG,MIN). LANCASTER CO.: Mountville, May 18, 1888, *Eby* (MBG); Conewago, Apr. 23, 1892, *Small* (MBG,MIN); on rocks, Rheinholds, Sept. 3, 1894, *Eby* (MBG); Bear Town, Sept. 16, 1895, *Eby* (MBG); on rails, Landis Valley, Oct. 1892, *Eby* (MBG); on rocks, Bear Town, Oct. 1895, *Eby* (MBG); Kissel Hill, July 17, 1895, *Eby* (MBG); on trees, Kissel Hill, Oct. 1895, *Eby* (MBG).

NORTH CAROLINA: MITCHELL CO.: on bark of tree, Roan Mountain, June 15, 1936, *Schallert* (B). HAYWOOD CO.: on oak trees, vicinity of Eagles Nest, near Waynesville, elev. 1000–1500 m., Sept. 12, 1910, *Standley* (US). SWAIN CO.: wet woods, Clingmans Dome, elev. 6600 ft., Aug. 10, 1939, *Hubricht B1579* (MBG). MC DOWELL CO.: Mount Mitchell, June 5, 1929, *Youngken 9* (BPI). COUNTY INDEFINITE: bark of tree, Great Smoky Mountains, June 13, 1936, *Schallert* (B).

FLORIDA: ORANGE CO.: on trunks of *Myrica*, Sanford, Dec. 1907, *Rapp* (MBG).

OHIO: CHAMPAIGN CO.: in cedar swamp, Aug. 9, 1892, *Werner L453* (O).

MICHIGAN: KEWEENAW CO.: Isle Royale, Aug. 7, 1901, *Stuntz & Allen 33* (WIS); covering boulders and cliffs, Rock Harbor, Isle Royale, Aug. 1904, *Harper & Harper 160* (FM).

WISCONSIN: VILAS CO.: valley of the Wisconsin River, near Conover, June 26, 1893, *Cheney 798* (WIS). MARATHON CO.: valley of the Wisconsin River near Granite Heights, Summer 1894, *Cheney 3014* (WIS). COUNTY INDEFINITE: valley of the Wisconsin River, near Doherty Lake, Summer 1893, *Cheney 1150* (WIS).

MINNESOTA: COOK CO.: on rocks, Grand Portage Island, June 24, 1897, *Fink 169* (MIN); on cedar, Grand Marais, Aug. 2, 1902, *Fink 5284* (MIN). LAKE CO.: on rocks, Snowbank Lake, June 26, 1897, *Fink* (D); on trees, Beaver Bay, July 14, 1897, *Fink 725* (MIN). ST. LOUIS CO.: on mossy rocks, frequent, Harding, Aug. 19, 1901, *Fink 1612* (MIN). CARLTON CO.: on rocks, common, Kettle Falls, Aug. 10, 1901, *Fink 1366* (MIN). KOOCHICHING CO.: on cedars in swamp, rare, Koochiching, July 29, 1901, *Fink 998* (MIN); on rocks, Gunflint, July 1, 1897, *Fink 368* (MIN); on mossy rocks, frequent, Rainy Lake City, Aug. 5, 1901, *Fink 1214* (MIN). COUNTY UNKNOWN: on rocks, South Fowl Lake, June 26, 1897, *Fink 205* (MIN); on trees, Misquah Hills, July 5, 1897, *Fink 543* (MIN).

WASHINGTON: SNOHOMISH CO.: on trees, Maryville, Jan. 1926, *Grant* (F). ISLAND CO.: Goose Rock, Langley, July 1923, *Grant* (D).

CALIFORNIA: ORANGE CO.: Laguna Beach, elev. 50 ft., June 10, 1930, *Reed* (MBG).

47a. Parmelia cetrarioides var. **rubescens** (Th. Fries) DR., Nyt. Mag. **62**: 75. 1924.

Parmelia perlata f. *rubescens* Th. Fries, Lichenogr. Scand. **1**: 112. 1871.

Fries' type was collected in Norway and is in Upsala. DuRietz's type was from the mountains of southern Europe, and is now in the Paris Museum, France.

The variety has a very limited distribution and may be only an environmental variant. It differs from the species only in the chemical reaction with KOH. In the variety the medulla becomes reddish-brown when treated with KOH, while $CaOCl_2$ gives no reaction.

Distribution: found only in the southern part of Pennsylvania.

PENNSYLVANIA: PHILADELPHIA CO.: on fence rails, Chestnut Hill, Oct. 1886, *Eby* (MBG). LANCASTER CO.: on fences, Kissel Hill, Oct.–July 1895, *Eby* (MBG).

FOREIGN EXSICCATAE EXAMINED: Claud. *66;* Harm. Lich. Loth. *288;* Mus. Krypt. Exs. Vind. *1365.*

48. Parmelia crinita Ach., Syn. Meth. Lich. 196. 1814.

Imbricaria crinita Ach. apud Arn., Flora **67**: 159. 1884.

The type of *Parmelia crinita* was a collection of Muhlenberg's from eastern North America, probably Pennsylvania. The type is now in Acharius' herbarium in Helsinki, Finland.

Arnold cites *Imbricaria crinita* Ach. as a related species. Nothing is known of a type for *Imbricaria crinita.*

Type locality: eastern North America (probably Pennsylvania).

Thallus 4–18 cm. diameter, loosely adnate; upper surface with many granules or isidia, pale green or gray-green, lobes broad, irregular, margins slightly ciliate, wavy and dissected; lower surface brown at the margins, black with many rhizinae at the center; apothecia not common, 3–13 mm. diameter, disks chestnut-brown, concave, amphithecia irregular, often with

isidia or granules, sometimes ciliate; K, yellow, C, none, K + C, none, P, none.

Algal layer continuous, 28–30 μ thick; upper cortex 24–28 μ thick, matrix light brown; medulla loosely interwoven with hyaline hyphae of small diameter; lower cortex 35–40 μ thick, matrix black or brown; thickness of thallus 304–320 μ; thecium 40–60 μ thick; ascus clavate, spores 8, 6–8 × 12–16 μ; paraphyses branched with the tips enlarged.

Distribution: Ontario to Florida, west to British Columbia and Washington.

ONTARIO: on trees in woods, Brighton, Oct. 18, 1893, *Macoun 175* (WIS); on trees in woods, Brighton, Oct. 18, 1893, *Macoun* (MBG,MIN).

MAINE: KNOX CO.: Rockland, Sept. 8, 1909, *Merrill 124* (MIN); Rockport, Nov. 1904, *Merrill 844* (F); on the trunks of an old birch, solitary, Rockland, Aug. 10, *Merrill* (F); 1839, *DeLaski* (FM).

MASSACHUSETTS: BRISTOL CO.: on trunks and rocks, New Bedford, *Willey 28* (FM); on trees, Hingham, *Russell* (FM); New Bedford, *Willey 38* (FM); New Bedford, 1862–1898, *Willey* (US). PLYMOUTH CO.: Plymouth, Mar. 1884, *Faxon* (F).

VIRGINIA: LEE CO.: edge of woods, Hunters Gap, Powell Mountain, 2.7 miles north of Blackwater, *Hubricht B393* (MBG).

NORTH CAROLINA: ROWAN CO.: Dunn's Mountain, Aug. 21, 1894, *Small* (MIN). HENDERSON CO.: on bark of tree, Flat Rock, Mar. 1, 1921, *Schallert 1969* (FM). HAYWOOD CO.: Sunburst, elev. 3200 ft., June 1913, *House* (NYBG).

SOUTH CAROLINA: AIKEN CO.: Aiken, *Ravenel* (MBG).

GEORGIA: THOMAS CO.: Thomasville, Aug. 1906, *Taylor* (F); on trees, Thomasville, *Taylor* (F).

FLORIDA: LAKE CO.: Eustis, May 28, 1895, *Nash* (MBG).

ALABAMA: BALDWIN CO.: on magnolia, Attler, Mar. 29, 1925, *Evans* (NYBG); on trees, Fairhope, Oct. 7, 1924, *Evans* (NYBG); trees on the beach, Daphne, Oct. 15, 1924, *Evans* (NYBG); base of trees near Rock Creek, Feb. 27, 1925, *Evans* (F).

MISSISSIPPI: HARRISON CO.: Biloxi, Sept. 15, 1891, *Seymour* (F). TATE CO.: 2 miles north of Coldwater, Dec. 27, 1938, *E. Anderson* (MBG).

LOUISIANA: ST. MARTIN CO.: on tree trunks, St. Martinsville, *Langlois* (NYBG).

OHIO: FRANKLIN CO.: Georgesville, July 15, 1892, *Bogue* (O).

MICHIGAN: FAYETTE CO.: on tree, 1893, *Fink* (MBG).

TENNESSEE: HAMILTON CO.: on trees, Lookout Mountain, *Calkins* (NYBG,MBG).

ILLINOIS: MENARD CO.: on tree, 1878, *Hall* (FM); *E. Hall 6* (FM).

WISCONSIN: WALWORTH CO.: on trees, Springfield, May 27, 1893, *Heald & Buell* (WIS). MARATHON CO.: valley of the Wisconsin River, near Knowlton, Summer 1894, *Cheney* (WIS).

MINNESOTA: COOK CO.: on rocks, Grand Portage, June 23, 1897, *Fink* (M); on rocks, Grand Portage, June 25, 1897, *Fink 114* (MIN). BLUE EARTH CO.: on trees, rare, Mankato, June 23, 1899, *Fink 47* (MIN); on trees, rare, Mankato, June 27, 1899, *Fink 133* (MIN). YELLOW MEDICINE CO.: on trees and rocks, Granite Falls,

July 11, 1899, *Fink 439* (MIN). CLAY CO.: on trees, rare, near Ulen, July 4, 1899, *Fink 228* (MIN); on mossy rocks in shade, rare, near Ulen, July 5, 1899, *Fink 258* (MIN). KOOCHICHING CO.: on rocks, Gunflint, July 1897, *Fink 362* (MIN). CARLTON CO.: on trees, Tafte, July 19, 1897, *Fink 133* (MIN).

IOWA: MUSCATINE CO.: on bark, Wild-cat-den, Nov. 1897, *Shimek* (IA). FAYETTE CO.: on trees, Mar. 1893, *Fink* (MIN,WIS,M).

MISSOURI: DUNKLIN CO.: on tree trunks, St. Francis, Aug. 20, 1897, *Trelease* (MBG). WRIGHT CO.: on dead *Acer saccharum*, 2 miles southwest of Mansfield, elev. 1480 ft., June 5–12, 1911, *Lansing Jr. 3200* (FM).

ARKANSAS: BOONE CO.: rocky wooded bluff, above dry creek bed, Bear Creek Spring, 0.5 mile north of Francis, Apr. 7, 1939, *Dodge, Berry & Johnson* (MBG).

KANSAS: DOUGLAS CO.: on trees, Nov. 1896, *Bridwell 1185* (F).

TEXAS: GILLESPIE CO.: *Jermy 424* (MBG). BEXAR CO.: mesquite woods, 1.5 miles southeast of junction of Jolly Lane and Atkins-Elmendorf Lane, 18 miles east of San Antonio, May 17, 1940, *Hubricht B1886* (MBG).

BRITISH COLUMBIA: on the old wharf, Comex, Vancouver Island, June 24, 1893, *Macoun 149* (MIN); June 1915, *Macoun 19* (F); on trunks in woods, Ucluelet, Vancouver Island, May 11, 1909, *Macoun* (MBG).

WASHINGTON: SKAGIT CO.: on rocks, Anacortes, July 12, 1908, *Frye* (D).

49. Parmelia cristifera Tayl., Hook. London Jour. Bot. **6**: 165. 1847.

The type of the species was collected by Wallich in Calcutta, India. The type plant is in Taylor's Herbarium in the Boston Society of Natural History.

Thallus 5–15 cm. diameter, adnate; upper surface smooth, greenish-gray to ashy or white, lobes round and broad, margins raised, bearing globose powdery soredia; lower surface with brown margins, naked, black at the center with a few black rhizinae; apothecia rare; K, upper cortex yellowish-green, medulla reddish-brown; C, none, K + C, medulla brown, P, red-brown.

Algal layer continuous, 16–20 μ thick, matrix hyaline; medulla hyphae loosely interwoven, hyaline; lower cortex 20–28 μ thick, matrix black; thickness of thallus 120–125 μ; thecium 60–96 μ thick; ascus clavate, spores 8, 2–4 × 6–8 μ; paraphyses branched.

Distribution: North Carolina to Florida, west to California.

NORTH CAROLINA: FORSYTH CO.: Bennetts Rock, Apr. 10, 1936, *Schallert* (MBG). HENDERSON CO.: Hendersonville, Apr. 1910, *Plitt 268* (F). JACKSON CO.: on bark of tree, Balsam Mountains, Sept. 8, 1922, *Schallert 6753* (WIS).

GEORGIA: THOMAS CO.: on oak bark, Thomasville, Aug. 1906, *Taylor* (F).

FLORIDA: DUVAL CO.: on trees, Jacksonville, *Calkins 10* (US). ORANGE CO.: on

fence, Mar. 1907, *Rapp* (F); Sanford, Mar. 1907, *Rapp* (F); on *Melia*, Sanford, May 1905, *Rapp 9* (F). LAKE CO.: Eustis, June 16, 1895, *Nash 2037* (US). HILLSBORO CO.: north side of dead stump, Tampa, Aug. 1898, *Ferguson* (US). LEE CO.: on cypress trees, Fort Myers, Mar. 17, 1916, *Standley 326* (MBG).

ALABAMA: BALDWIN CO.: on *Melia*, Fairhope, Feb. 25, 1925, *Evans* (F).

ARKANSAS: CHICOT CO.: near Macon, Dec. 29, 1938, *E. Anderson* (MBG). WHITE CO.: near Judsonia, Dec. 28, 1938, *E. Anderson* (MBG).

OKLAHOMA: COMANCHE CO.: vicinity of Fort Sill, May 20, 1916, *Mrs. J. Clemens* (D).

TEXAS: HARRIS CO.: on *Pinus glabra*, Clinton, Mar. 22, 1925, *Thurow* (F). DENTON CO.: on *Quercus minor*, 3 miles southwest of Denton, Feb. 1935, *Bussard VII & VIII* (MBG). COMAL CO.: Packsaddle, 500 ft. above the bed of Guadalupe River, 1916, *Stafford* (MBG). BEXAR CO.: semi-shade to full sun, 1 mile southwest of Selma, May 22, 1938, *Hubricht B762* (MBG). GILLESPIE CO.: *Jermy 873* (MBG). LA SALLE CO.: Millett, Nov. 1897, *Trelease* (US). CULBERSON CO.: full sun to semi-shade, north side of summit of Van Horn Mountains, 15 miles south of Van Horn, June 2, 1938, *Hubricht B951* (MBG).

CALIFORNIA: SAN DIEGO CO.: on dry bushes, Camp Kearney, Mesa, elev. 600 ft., 1932, *Cota* (MBG).

50. Parmelia perforata (Wulf.) Ach., Meth. Lich. 217. 1803.

Lichen perforatus Wulf. apud Jacq., Collect. 1: 116. 1786.

Platisma perforatum Hoffm., Descr. & Adumbrat. Pl. Lich. 1: 65. *t. 13, f. 1.* 1790.

Wulfen's type was from a plant collected in central Europe. Its present location is unknown, but the plate shown by Jacquin is in agreement with the description. Hoffmann cites Wulfen's *Lichen perforatus* as synonymous with his plant. His type is unknown. Acharius' plant was collected by Michaux in the eastern part of North America. His type is in Helsinki, Finland, with a co-type in Upsala, Sweden.

Thallus large, loosely adnate; upper surface smooth, greenish-gray to brownish-gray, lobes round, wide, with raised margins, becoming subfruticose, dissected and imbricate, with a fringe of black cilia, spotted with numerous black ostioles of spermagonia; lower surface black at the center, with numerous black rhizinae, margins naked, white or brown; apothecia numerous, 1–15 mm. diameter, short-pedicellate, lower sides reticulate, ridged, disks brown to chestnut-brown, concave or flat, usually perforate in the center, margins wavy and broken; K, yellow becoming pink or red, C, none, K + C, pink, P, none.

Algal layer continuous, 40–45 μ thick; upper cortex 28–30 μ

thick, matrix brown; medulla hyphae loosely interwoven, of one type, hyaline and of small diameter; lower cortex 16–32 μ thick, matrix black; thallus 250–266 μ thick; thecium 26–40 μ thick; ascus clavate, spores 8, 5–8 × 9–12 μ; paraphyses branched, enlarged at the tip.

Distribution: Massachusetts to Florida, west to California.

MASSACHUSETTS: BRISTOL CO.: on trunks, common, New Bedford, *Willey 31* (FM); trunks, New Bedford, *Willey 30* (FM); New Bedford, 1908, *Everhart* (MBG). PLYMOUTH CO.: Hingman, 1846, *Russell* (FM). WORCESTER CO.: on rocks, Lunenburg, 1883, *Sargent 219* (F). NORFOLK CO.: Wellesley, Dec. 21, 1883, *Cummings* (WIS). COUNTY UNKNOWN, 1863, *Mann* (FM); on rocks, *Russell* (WIS).

CONNECTICUT: NEW HAVEN CO.: New Haven 1855, *Eaton* (F).

NEW YORK: SUFFOLK CO.: East Port, Long Island, June 24, 1894, *Schrenk* (MBG). YATES CO.: Penn Yan, *Buckley* (F).

NEW JERSEY: CUMBERLAND CO.: on various trees, Vineland, Dec. 1893, *Walker 22* (FM,MBG,WIS,MIN).

PENNSYLVANIA: CHESTER CO.: on rocks, Nov. 10, 1879, *Rothrock* (FM); on living and dead trees, common, Mar. 27, 1879, *May & Rothrock* (FM). LANCASTER CO.: on oak trees, Conewago, Nov. 25, 1852, *Heller* (F); on rails, Rheinholds, Mar. 14, 1896, *Eby* (MBG).

MARYLAND: BALTIMORE CO.: on fence rail, Sept. 19, 1909, *Plitt* (F). CAROLINE CO.: on plum tree, Denton, Apr. 1898, *Waugh* (F).

NORTH CAROLINA: FORSYTH CO.: on twigs, Niford Rock, June 1, 1934, *Schallert* (B); on bark of tree, Winston-Salem, Apr. 12, 1921, *Schallert 1289* (WIS,F). BUNCOMBE CO.: vicinity of Montreal, Sept. 1, 1913, *Standley & Bollman* (F). HENDERSON CO.: on bark of tree, Flat Rock, Mar. 1, 1921, *Schallert 1286* (FM); on bark of tree, Flat Rock, Mar. 1, 1922, *Schallert 6752* (FM); on exposed rock, Flat Rock, Mar. 12, 1921, *Schallert 1289* (FM).

SOUTH CAROLINA: BEAUFORT CO.: on twigs, sand dunes, Pawleys Island, Aug. 2, 1936, *Schallert* (B). SPARTANBURG CO.: Glenn Springs, *Ravenel* (T).

FLORIDA: ORANGE CO.: trunk of orange tree, Lake Mary, Feb. 14, 1909, *Rapp* (F). DUVAL CO.: shrubs, Jacksonville, *Calkins* (MBG). CLAY CO.: June 21, 1879, *Martin* (FM). COUNTY UNKNOWN: winter of 1879–80, *Martin* (FM).

ALABAMA: MOBILE CO.: Mobile, 1852, *Litsbee* (FM); Mobile, *Mohr* (MBG). LEE CO.: limbs, Auburn, Jan. 9, 1897, *Earle & Baker* (MBG).

LOUISIANA: PLAQUEMINES CO.: on trees, Pointe a la Hache, 1884, *Langlois 36* (MBG). LA FOURCHE CO.: Kraemer, Apr. 18, 1936, *Hubricht* (MBG). COUNTY UNKNOWN: May 7, 1889, *Langlois 363* (MBG).

OHIO: ADAMS CO.: Mineral Springs, Oct. 24, 1900, *Kellerman* (O). CLARK CO.: Luyden Wood, Springfield, Feb. 9, 1877, *Biddlecombe* (O); near Springfield, 1872, *Spence* (O). CHAMPAIGN CO.: cedar swamp, Sept. 10, 1892, *Weaver* (W).

WEST VIRGINIA: COUNTY UNKNOWN: on trees, *Gray* (F).

TENNESSEE: CLAIBORNE CO.: open woods, 8 miles east of Tazewell, Aug. 22, 1937, *Hubricht B368* (MBG). HAMILTON CO.: on pine bark, Lookout Mountain, *Calkins 7* (FM).

WISCONSIN: LAFAYETTE CO.: Fayette, July 15, 1894, *Cheney 9220* (WIS).

ILLINOIS: MENARD CO.: on trees, 1878, *Hall* (FM); *Hall 4* (FM); Athens, 1864, *Hall* (FM); Athens, 1878, *Hall* (FM,T,BSNH,MBG). COUNTY UNKNOWN: on trees, *Calkins* (FM).

MINNESOTA: BLUE EARTH CO.: on trees, rare, Mankato, June 26, 1899, *Fink 134* (MIN).

IOWA: HENRY CO.: on bark, Jan. 1, 1898, *Savage* (IA).

MISSOURI: WAYNE CO.: old trees, Williamsville, Mar. 1898, *C. Russell* (MBG). FRANKLIN CO.: bark of tree, Gray Summit, Nov. 15, 1936, *Berry* (MBG).

ARKANSAS: NEWTON CO.: high bluff and long steep wooded hillside, Lookout Point, 7 miles south of Jasper, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG); steep dry wooded bluff with rocky flat top, 1 mile south of Ponca, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG); wooded hillside, 11 miles south of Harrison, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG). CONWAY CO.: Petit Jean State Park, May 5, 1940, *Hubricht B1917* (MBG).

KANSAS: DOUGLAS CO.: on trees, Nov. 1896, *Bridwell 87* (F).

OKLAHOMA: COMANCHE CO.: vicinity of Fort Sill, May 20, 1916, *Mrs. J. Clemens* (MBG).

TEXAS: GALVESTON CO.: Galveston, *Hall* (FM). HARRIS CO.: Houston, *Hall* (FM); on living oaks, La Port, elev. 15 ft., Jan. 9, 1939, *Fisher* (MBG). DENTON CO.: three miles southwest of Denton, 1935, *Bussard* (MBG). GILLESPIE CO.: Coal Creek, *Jermy 423* (MBG). BEXAR CO.: mesquite woods, 1.5 miles southeast of junction of Jolly Lane and Atkins-Elmendorf Lane, 18 miles east of San Antonio, May 17, 1940, *Hubricht B1892* (MBG); semi-shade to full sun, 1 mile southeast of Selma, May 22, 1938, *Hubricht B768* (MBG).

CALIFORNIA: SONOMA CO.: mossy sandstone, Stony Point near Searsville, elev. 400 ft., July 9, 1903, *Herre* (F). LOS ANGELES CO.: on *Quercus dumosa*, mountain top, Santa Catalina Island, June 12, 1920, *Nuttall* (FM). SAN DIEGO CO.: on trees, Alpine Creek, elev. 1000 ft., July 28, 1903, *Herre* (MIN); San Diego, 1888, *Palmer* (MBG).

50a. Parmelia perforata var. **hypotropa** Nyl., Syn. Lich. **1**: 378. 1860.

Nylander's type of the variety was collected on trees in Texas, and is in his herbarium in Helsinki, Finland.

The variety differs from the species only in the small size of the thallus and the light lower surface.

Distribution: Florida west to Texas.

FLORIDA: DUVAL CO.: on trees, mouth of St. Johns River, Mar. 31, 1921, *Kelly* (BPI); PALM BEACH CO.: 1898, *Thaxter 2043* (F).

TEXAS: BLANCO CO.: on oaks, Blanco, 1848, *Wright* (T). BRAZOS CO.: Bryan, June 22, 1919, *Nelson* (BPI).

51. Parmelia proboscidea Tayl. apud Mack., Fl. Hibern. **2**: 143. 1836.

Parmelia frondifera Merrill, Bryol. **11**: 91. 1908.

Taylor's type was collected in Dunkerron, Ireland, and is now in his herbarium in the Boston Society of Natural History. Merrill's type was collected by Macoun at Peele Point, Ontario, Canada, and is now in the Farlow Herbarium.

Thallus large, round, adnate, upper surface covered with finely divided lobules, white globose soredia common on the older parts, margins with fine cilia; lower surface brown at the margins, black at the center, with many black rhizinae; apothecium 9–15 mm. diameter, pedicellate, abundant, disk deeply concave, chestnut-brown, not perforate, amphithecium sometimes fissured with vertical ridges; K, yellow, C, none, K + C, none, P, none.

Algal layer continuous, 18–30 μ thick; upper cortex 36–38 μ thick, matrix brown; upper portion of medulla of loosely interwoven, small, hyaline hyphae, lower portion of brown hyphae of large diameter; lower cortex 24–30 μ thick, matrix dark brown or black; thickness of thallus 105–120 μ.

Distribution: Ontario to Florida, west to Texas.

ONTARIO: on trees, Peele Point, 1890, *Macoun* (F).

MASSACHUSETTS: BRISTOL CO.: on trunks, common, New Bedford, *Willey 31* (FM).

MARYLAND: ANNE ARUNDEL CO.: on decaying trunk of tree in woods, Cornfield Creek, Aug. 26, 1906, *Plitt* (D).

FLORIDA: ORANGE CO.: on trees, Sanford, May 5, 1922, *Rapp* (D); on oak trunks, Sanford, Aug. 12, 1906, *Rapp* (D); on trees, Sanford, Mar. 1920, *Rapp* (WIS); Sanford, Jan. 24, 1909, *Rapp 26* (F).

TENNESSEE: COUNTY UNKNOWN: on bark of elms, *Calkins 2* (FM).

TEXAS: BEXAR CO.: semi-shade to full sun, 1 mile southwest of Salem, May 22, 1938, *Hubricht B769* (MBG).

FOREIGN EXSICCATAE EXAMINED: Wain. *400*.

52. Parmelia tinctoria Despr. apud Nyl., Flora **55**: 547. 1872.
Parmelia praetervisa Müll.-Arg., Flora **63**: 276. 1880.

Despreaux's type was collected in the Canary Islands and is now in the Paris Museum, France. Müller-Argau's type was collected by Zollinger in Java, and is now in Geneva, Switzerland.

Thallus large, 15–35 cm. diameter, loosely adnate to bark or wood; upper surface with isidia or coralloid branchlets, wrinkled, light gray to white or ashy in color, lobes large,

round, slightly crinkled, imbricated, with smooth margins; lower surface brown at the margins, black toward the center with very few scattered black rhizinae at the places of contact with the substratum; apothecium 2–8 mm. diameter, subpedicellate, disk concave, light brown to chestnut-brown, amphithecium smooth or slightly isidiose; K, upper cortex yellow; C, medulla none, K + C, none, P, none.

Algal layer continuous, 16–20 μ thick; upper cortex 16–18 μ thick, matrix yellow; medulla loosely interwoven, with one type of hyphae; lower cortex 18–20 μ, matrix dark brown or black; thallus 160–200 μ thick; thecium 6–70 μ thick; ascus clavate, spores 8, 4–5 × 8–10 μ; paraphyses branched.

Distribution: North Carolina to Florida, west to Texas.

NORTH CAROLINA: FORSYTH CO.: on exposed rock and base of tree, Box Mountain near Walkertown, July 11, 1922, *Schallert 6767* (WIS).

GEORGIA: THOMAS CO.: on trunks, Thomasville, *Taylor* (F); Thomasville, Aug. 24, 1906, *Taylor* (F).

FLORIDA: DUVAL CO.: Jacksonville, *Calkins* (MBG). ORANGE CO.: on fence, Sanford, Mar. 1921, *Rapp* (WIS); on trunks of trees, Sanford, 1909, *Rapp* (F); on fence, Sanford, Dec. 1906, *Rapp* (F). LAKE CO.: Eustis, May 28 to June 15, 1895, *Nash* (F,MBG). HILLSBORO CO.: north side of dead stump, Tampa, Aug. 1898, *Ferguson* (MBG); north side of small oak tree, Tampa, Aug. 7, 1898, *Ferguson* (MBG).

ALABAMA: BALDWIN CO.: on tree, Shelby's, Mar. 17, 1925, *Evans* (F). MOBILE CO.: Mobile, Jan. 1905, *Jones* (MBG).

LOUISIANA: ORLEANS CO.: hardwoods near Indian Village near New Orleans, Dec. 31, 1931, *Dodge* (MBG). LA FOURCHE CO.: on tree, Kraemer, Apr. 15, 1936, *Hubricht* (D). ST. MARTIN CO.: mostly on trunks of trees, St. Martinsville, Jan. 3, 1894, *Langlois* (F); on fences and various trees, St. Martinsville, 1893–1894, *Langlois* (MBG,MIN).

ARKANSAS: CHICOT CO.: near Macon, Dec. 29, 1938, *Anderson* (MBG).

TEXAS: HARRIS CO.: Clinton, Mar. 5, 1925, *Thurow* (F).

53. Parmelia latissima Fée, Suppl. Essai Crypt. Ecor. Officin. 119. 1837.

Fée's type was collected on the island of Jamaica and is now in the Paris Museum, France.

Thallus large; upper surface with soredia, ashy to greenish-gray, lobes short, wide, margins round, smooth, somewhat ascending; lower surface chestnut-brown, black at the center, rhizinae scattered, black; apothecium 2–10 mm. diameter, sessile, disk concave, chestnut-brown, amphithecium smooth; K, red, C, intense red, K + C, none, P, brick-red.

Algal layer continuous, 20–40 μ thick; upper cortex 2–24 μ thick; medulla of closely interwoven hyphae; lower cortex 20–24 μ thick, matrix black, thallus 200–250 μ thick; thecium 140–181 μ thick; ascus clavate, spores 8, 12–16 × 32–36 μ; paraphyses branched, enlarged at the tips.

Distribution: Florida west to Louisiana, north to Arkansas.

FLORIDA: DUVAL CO.: on trees, Jacksonville, *Calkins 341* (FM). ORANGE CO.: on trunks of trees, Sanford, 1909, *Rapp* (MIN); Sanford, Jan. 24, 1909, *Rapp 26* (F); on logs, Sanford, Mar. 1921, *Rapp* (F); on trees, Sanford, Oct. 1923, *Rapp* (BPI); on logs in damp woods, Apr. 1906, *Rapp* (BPI); vicinity of Oviedo, Dec. 1922, *Rapp 660* (BPI). CLAY CO.: Jan. 20, 1879, *Martin* (FM); COUNTY UNKNOWN: on cypress swamps, *Calkins* (NYBG).

ALABAMA: COLBERT CO.: base of tree, near Rock Creek, Feb. 27, 1925, *Evans* (NYBG).

LOUISIANA: ST. MARTIN CO.: on fences and various trees, St. Martinsville, 1893–1894, *Langlois* (WIS,F).

ARKANSAS: NEWTON CO.: 1899, *Trelease* (MBG); high bluff and long steep wooded hillside, Lookout Point, 7 miles south of Jasper, Apr. 8, 1939, *Dodge, Berry & Johnson* (MBG).

PSEUDEVERNIA

IV. Parmelia subgenus **Pseudevernia** (Zopf) Berry. n. subgenus.

Parmelia section *Canalicularia* Ach., Meth. Lich. 254. 1803.

Parmelia section *Everniiformes* Hue, Nouv. Arch. du Mus. Paris, IV. **1**: 135. 1899.

Pseudevernia Zopf, Beih. z. Bot. Centr. **14**: 124. 1903.

Parmelia subgenus *Euparmelia* section 1. *Everniaeformes* Zahlbr. apud Engler & Prantl, Nat. Pflanzenfam. I. Teil, Abt. 1: 212. 1907.

Acharius used the section *Canalicularia* in his 'Meth. Lich.' 254. 1803, to segregate those lichens which have long and narrow erect lobes. This group included *Parmelia villosa* Ach., which has been placed in the genus *Teloschistes* by Norman (Nyt. Mag. **7**: 309. 1853), and *Parmelia furfuracea* (L.) Ach., which has been cited as typical by all subsequent workers on this group. Of the remaining twenty species included by Acharius, all have subsequently been placed in other genera. *Parmelia furfuracea* (L.) Ach. is typical of Hue's *Everniiformes*. Zopf established *Pseudevernia* as a genus to include the lobate forms, and considered *Parmelia furfuracea* (L.)

Ach. as the type. Zahlbruckner used *Everniaeformes* to designate the section of the subgenus *Euparmelia* in which he placed the group. His type was *Parmelia furfuracea* (L.) Ach. The writer believes that the lobate forms of the genus *Parmelia* are distinct enough to warrant their being placed in a distinct subgenus, and has designated the use of *Pseudevernia* Zopf in this category, with *Parmelia furfuracea* (L.) Ach. as the type.

Thallus lobes long and narrow, more or less fruticose in growth, usually imbricated, and in some species with strong black marginal cilia; lower surface channeled, rhizinae papillose or absent except at the center of the thallus; spores 8, to an ascus.

The subgenus is distributed throughout the world in the mountainous regions.

KEY TO SPECIES IN SUBGENUS PSEUDEVERNIA

A. Always with marginal cilia.....54. *cirrhata*
A. Never with marginal cilia.
  B. Lobes flat at tip; plant coarse, usually with soft scales.....55. *furfuracea*
  B. Lobes cylindrical at tip; plant always delicate.....56. *Cladonia*

54. Parmelia cirrhata Fries, Syst. Orb. Veget. pars 1: 283. 1825.

Evernia kamtschadalis Mont., Ann. Sci. Nat. Bot. II. **18**: 17. 1842.

Evernia americana Mey. & Fw., Nova Acta Acad. Leopold.-Carol. **14**: 211. 1843.

Parmelia Nepalensis Tayl., Hook. London Jour. Bot. **6**: 172. 1847.

Parmelia americana Mont., Ann. Sci. Nat. Bot. III. **18**: 309. 1852.

Parmelia camtschadalis f. *americana* Nyl., Ann. Sci. Nat. Bot. IV. **11**: 215. 1859.

Fries' type was collected in Nepal, India, and at present is in Upsala, Sweden. Montagne described *Evernia kamtschadalis* from a plant collected in Chile, South America. He considered it as closely related to *Borreri furfuracea* Ach. (Lich. Univ. 500. 1810) but with thinner lobes and ciliate margins. Montagne's type is in the Paris Museum, France. Meyer and Flotow based

their *Evernia americana* on a plant collected in Bolivia, South America. Their type is in Berlin, Germany. *Parmelia Nepalensis* of Taylor was based on a collection from Nepal, India, by Wallich, and the type is in Hooker's Herbarium in London, England. Montagne considered the same type in *Parmelia americana* as he used to describe his *Evernia kamtschadalis*. *Parmelia camtschadalis* f. *americana* of Nylander was based on collections from Bolivia and Peru, South America. His type is in Helsinki, Finland. *Parmelia cirrhata* Fr. represents a species with wide distribution in the mountains of the tropics and is an extremely variable species.

Thallus fruticose, upper surface smooth, without soredia or cracks in cortex, lobes flattened, more or less erect, from 2 to 9 mm. broad, tips dichotomously forked, margins always with numerous strong black cilia; lower surface black, smooth or with many strong black rhizinae; apothecium 4–14 mm. diameter, concave to flat, chestnut-brown, margin of amphithecium broken or entire; K, none, C, none, K + C, none, P, yellow.

Algal layer continuous, 7–20 μ thick; upper cortex 40–50 μ thick, matrix of yellow secretion; medulla hyphae loosely interwoven, hyaline, of one type and less than 1 μ diameter; lower cortex 30–40 μ thick, matrix black; thallus 185–200 μ thick; thecium 35–45 μ thick; ascus clavate, spores 8–10 × 18–20 μ, ellipsoid; paraphyses branched.

Distribution: Collected but once in North America, north of Mexico.

CALIFORNIA: SANTA CRUZ CO.: on trees and shrubs, Black Mountain, elev. 1500 to 2700 ft., July 9, 1903, *Herre* (F,LSU).

This species has a wide distribution in Mexico and Central America.

55. Parmelia furfuracea (L.) Ach., Meth. Lich. 254. 1803.
Lichen furfuraceus Linn., Sp. Pl. 1146. 1753.
Lichenoides furfuraceum Hoffm., Desc. & Adumbrat. Pl. Lich. **1**: 45. *t. 9, f. 2.* 1790.
Lobaria furfuracea Hoffm., Deutschl. Fl. **2**: 144. 1795.

Pseudevernia furfuracea Zopf, Beih. z. Bot. Centr. **14**: 124. 1903.

The type of Linnaeus was collected in the mountains of central or northern Europe, and is now in the Linnean Herbarium in London. Hoffmann (Desc. & Adumbrat. Pl. Lich. **1**: 45. *t. 9, f. 2.* 1790) gives a description and presents a plate which is clearly the same plant designated *Parmelia furfuracea* by Acharius. Hoffmann considered *Lichenoides furfuraceum* as synonymous with his *Lobaria furfuracea.* Acharius cites *Lichen furfuraceus* Linn. and *Lichenoides furfuraceum* Hoffm. as synonymous with *Parmelia furfuracea* Ach. Zopf considered his *Pseudevernia furfuracea* as synonymous with the Linnaean plant.

Thallus greenish-gray or ashy; lobes long, narrow, dichotomously and subpinnately branched, often imbricated, much divided toward the tips, usually bearing soft scales of coralloid branchlets; upper cortex smooth, unbroken by cracks; lower surface light at tips, becoming dark, channeled toward center, without rhizinae except in dark central portion, rhizinae black, short, thick; apothecium short-pedicellate, almost marginal, 3–15 mm. thick, flat or convex, disk brown to brownish-black, abundant, amphithecium smooth, regular, few or no fissures or lobes; K, upper cortex yellow; C, none; K + C, upper cortex yellow, P, medulla yellow.

Algal layer continuous, 21–35 μ thick; upper cortex 20–30 μ thick, matrix yellowish-brown; lower cortex 20–30 μ thick, matrix black or dark brown; medulla of two types of hyphae, those of the central portion of thallus hyaline, 0.5–1 μ thick, loosely interwoven, those at tips of lobes scattered, dark or black, 2–3 μ thick; thallus 340–400 μ thick; thecium 25–30 μ thick; ascus clavate, 8-spored, 3–5 × 5–8 μ, arranged irregularly in ascus.

European collections of this species resemble the American collection in every respect. In no instance was it possible to distinguish the plants on the basis of the origin of collection.

Distribution: Maine to South Carolina, west to California.

MAINE: KNOX CO.: on large branches of oak, Pine Hill, Rockport, Oct. 16, 1909, *Merrill* (F). CUMBERLAND CO.: on *Pinus rigida,* West Falmouth, Mar. 31, 1925, *Morton* (F).

NEW HAMPSHIRE: CARROLL CO.: Mount Whiteface, Aug. 1934, *Dodge* (MBG).

MASSACHUSETTS: BRISTOL CO.: New Bedford, 1908, *Everhart* (MBG).

CONNECTICUT: TOLLAND CO.: on trees in a bog, Willington, June 15, 1927, *Evans* (F).

PENNSYLVANIA: PIKE CO.: Matamoras, Sept. 22, 1896, *Schneider* (MBG). LANCASTER CO.: fence rail, Chestnut Hill, Oct. 15, 1894, *Eby* (MBG); Chestnut Hill, July 1889, *Eby* (MBG).

NORTH CAROLINA: AVERY CO.: on coniferous trees, Grandfather Mountain, Aug. 10, 1891, *Seymour* (MBG). BUNCOMBE CO.: pine trunk, vicinity of Montreal, Sept. 1, 1913, *Standley & Bollman 10239* (MBG). COUNTY INDEFINITE: mountains of North Carolina and Georgia, *Buckley* (MBG).

SOUTH CAROLINA: GREENVILLE CO.: Hog Back, Dec. 29, 1892, *Green* (MBG).

WEST VIRGINIA: POCAHONTAS CO.: Charles Creek, Oct. 1923, *Gray L245* (F).

KENTUCKY: BELL CO.: woods, north side of Pine Mountain, 5.5 miles east of Pineville, Aug. 19, 1927, *Hubricht B342* (MBG).

MINNESOTA: COOK CO.: Grand Marais, cedars in a swamp, Aug. 4, 1902, *Fink* (MIN).

TEXAS: BREWSTER CO.: on *Pinus cembroides* on north side of Mt. Emory, Chisos Mountains, July 2, 1837, *Warnock* (MBG); on *Pinus ponderosa*, ridge between Bob Manning and Little Ajuga Canyon, June 17, 1931, *Moore & Steyermark 3800* (MBG).

COLORADO: EL PASO CO: common on spruce, Palmer Lake, *Bettel* (F); near Pagosa Peak, Aug. 1899, *Baker 95* (MBG).

NEW MEXICO: EDDY CO.: on tree, near Queen, Aug. 12–30, 1924, *Standley 40685* (F). COLFAX CO.: moist soil, vicinity of Ute Park, Aug. 20, 1916, *Standley 13369* (F). SANDOVAL CO.: on branches of balsam and spruce trees, Sandia Mountains, Aug. 8, 1914, *Ellis* (MBG). SOCORRO CO.: shade, San Andres Mountain, Rhodes Pass, 47 miles west of Tularosa, June 1938, *Hubricht B987* (MBG).

ARIZONA: PIMA CO.: dead branches overhanging brook, Manning Camp, Rincon Mountains, Oct. 12, 1909, *Plummer 3470* (MBG). COUNTY UNKNOWN: rolling andesitic pine land recently lumbered, Barfoot Park, Sept. 26, 1906, *Plummer 1429* (MBG); 1909, *Plummer 3470* (MBG).

CALIFORNIA: SAN BERNARDINO CO.: bark and dead wood, *Pseudotsuga macrocarpa*, San Antonio Canyon, San Gabriel Mountains, elev. 4800 ft., Mar. 12, 1933, *Wheeler 1526* (MBG).

FOREIGN AND LOCAL EXSICCATAE EXAMINED: Ekart, *8;* E. Fries, *140;* Funck, I *11*, II *113;* Mus. Krypt. Exs. Vind. *156;* Malme, *61;* Oliv. *165;* Schaer. *387; P. furfuracea* f. *ceratea.* Mus. Krypt. Exs. Vind. *768; P. furfuracea* var. *isidiophora* Mus. Krypt. Exs. Vind. *876 a, b; P. furfuracea* subspec. *olivetorina* Mus. Krypt. Exs. Vind. *1046;* Malme, *505; Evernia furfuracea* f. *ceratea* Cromb. *139;* Harm. Lich. Loth. *258;* Hav. *251;* Johns. *67;* Oliv. *208; E. furfuracea* f. *curta* Britz. *756; E. furfuracea* f. *nuda* Britz. *523; E. furfuracea* a. *platyphylla* Rab. *250 (Coralloidea); E. furfuracea* f. *scobicina* Hav. *252;* Johns. *66; E. furfuracea* var. *soralifera* Harm. *64.*

56. **Parmelia Cladonia** (Tuck.) DR., Svensk Bot. Tidskr. **18**: 390. 1924.

Evernia furfuracea (L.) Mann var. *Cladonia* Tuck., Syn. Lich. New England, 12. 1848.

Tuckerman's type of the variety was based on a collection made in the White Mountains of New Hampshire, and is now in his herbarium in the Farlow Herbarium at Cambridge, Massachusetts. DuRietz cites Tuckerman's type in his transfer of the variety to specific rank in the genus *Parmelia*.

Thallus light greenish-gray, with ascending habit of growth, branching dichotomously, branches smooth, very slender, round and light yellow above but flattened and black toward the base; apothecia unknown; K, brown, C, none, K + C, brown, P, yellow.

Algal layer broken into masses 42–44 μ in diameter; upper cortex 31.5 μ thick; lower cortex 31.5 μ thick; medullary hyphae loosely woven, 2.1 μ in diameter; thallus 222–240 μ thick.

Parmelia Cladonia (Tuck.) DR. is distinguished from *Parmelia furfuracea* (L.) Ach. by having narrow smooth branches, without isidia or coralloid branchlets. No collections have been made which have apothecia.

Distribution: Nova Scotia to North Carolina.

NOVA SCOTIA: on spruce tree on gypsum cliff, Ste. Croix, Hants County, July 27, 1928, *Prince* (F).

MAINE: KNOX CO.: on twigs, Camden, Oct. 1885, *Merrill* (F); on branches, Mt. Battie, Camden, May 1, 1910, *Merrill* (F). OXFORD CO.: on black spruce in deep bog, Canton, July 31, 1928, *Parlin* (BPI).

NEW HAMPSHIRE: CARROLL CO.: Whiteface Mountain, Aug. 1934, *Dodge* (MBG). GRAFTON CO.: on coniferous trees, Mt. Liberty, Franconia Mountains, Aug. 1892, *Cummings & Seymour 49* (MBG). COOS CO.: White Mountains, top of Mt. Moriah, Sept. 1885, *Farlow 397* (F); White Mountains, *Tuckerman* (Type) (T).

VERMONT: LAMOILLE CO.: twigs of spruce, summit of Mt. Mansfield, 1922, *Merrill* (FM,MBG); Mt. Mansfield, dead tree, June 20, 1924, *Dutton 1694* (MBG); on dead balsam, region Mt. Mansfield, Hell Break Trail, *Dutton 1684* (F). WINDHAM CO.: old barn timbers, Pike Hollow, Wardsboro, July 3, 1935, *Moore* (MBG).

NEW YORK: ESSEX CO.: on balsam, Mt. Marcy, Lake Placid, June 10, 1935, *Darrow 858* (MBG).

MARYLAND: ALLEGHENY CO.: swamp, beyond Frostburg, Aug. 30, 1914, *Plitt 472* (BPI).

NORTH CAROLINA: MITCHELL CO.: on twigs, Roan Mountain, June 15, 1936, *Schallert 11355* (B). MC DOWELL CO.: Mt. Mitchell, June 15, 1929, *Youngken* (BPI). AVERY CO.: on twigs of trees, elev. 5000 ft., Grandfather Mountain, June 16, 1923, *Schallert* (F).

WEST VIRGINIA: POCAHONTAS CO.: Greenbank, Spring 1929, *Gray 11126* (NYBG).

TENNESSEE: SEVIER CO.: deep wet woods, Clingmans Dome, elev. 6600 ft., Aug. 10, 1939, *Hubricht B1581* (MBG); woods, Newfound Gap, elev. 5500 ft., Aug. 25, 1937, *Hubricht B552* (MBG); cool wet deep forest, Clingmans Dome, Aug. 25, 1937, *Hubricht B567* (MBG).

SUMMARY

On the basis of a critical morphological study, four subgenera, fifty-six species, and ten varieties are recognized in North America, north of Mexico. Three new species have been described and two new combinations formed. Reducing Zopf's genus *Pseudevernia* to subgeneric rank a new subgenus was established to include those lichens placed in the subgenus *Euparmelia* section *Everniaeformes* by Zahlbruckner.

DOUBTFUL AND EXCLUDED SPECIES

Parmelia ambigua (Wulf.) Ach., Meth. Lich. 207. 1803 = *Parmeliopsis ambigua* (Wulf.) Nyl., Syn. Lich. **2**: 54. 1860.

Parmelia ambigua var. *Halei* Tuck., Syn. N. Amer. Lich. 66. 1882 = *Parmeliopsis ambigua* var. *Halei* (Tuck.) Zahlbr., Cat. Lich. Univ. **6**: 13. 1929.

Parmelia arizonica (Tuck.) Nyl., Lich. Jap. 104. 1890, should be in the family Gyrophoraceae.

Parmelia atrofusca (Schaer.) Crombie, Grevillea **7**: 99. 1879, insufficient data.

Parmelia colpodes (Ach.) Nyl., Syn. Lich. 404. 1858 = *Anzia colpodes* (Ach.) Stizen., Flora **45**: 243. 1862.

Parmelia Frankliniana Tayl., Hook. London Jour. Bot. **6**: 167. 1847, insufficient data.

Parmelia Halseyana Tuck., Boston Jour. Nat. Hist. **3**: 442. 1841, belongs in the genus *Lecanora*.

Parmelia margaritata Hue, Nouv. Arch. Mus. Paris IV. **1**: 193. 1899, insufficient data.

Parmelia stuppea Tayl., Hook. London Jour. Bot. **6**: 175. 1847, belongs in the genus *Lecanora*.

ACKNOWLEDGMENTS

The writer wishes to express his appreciation to those who have so generously helped in this study. He is greatly indebted

to Dr. George T. Moore, Director of the Missouri Botanical Garden, for the privileges extended in the use of the library and herbarium. Thanks are also due Dr. David Linder and the other members of the staff of the Farlow Herbarium for their kindness in allowing the use of their herbarium and library in this study. The writer wishes especially to express his gratitude to Dr. C. W. Dodge, under whose guidance this study has been conducted, for giving so liberally of his time, making constructive criticisms, and extending the use of his private library and herbarium.

LIST OF EXSICCATAE, WITH ABBREVIATIONS USED

Bal.: Balansa, Plantes du Paraguay, 1888. *4176, 4210, 4234.* Bartl.: Bartling & Hampe, Vegetabilia Cellularia, 1832–1845. Dec. IV *7*, VIII *6.* Bohl.: Bohler, Lichenes Britannici or Specimens, 1835–1837. *11, 110.* Breut.: Breutel, Flora Germanica Exsiccata, 1832–1848. *402.* Britz.: Britzelmayr, Lichenes Exsiccati, 1903–?. *523, 756.* Claud.: Claudel & Harmand, Lichenes Gallici praecipui Exsiccati, 1903–1913. *15, 17, 19, 66, 117, 173, 258, 261, 506.* Cromb.: Crombie, Lichenes Britannici Exsiccati, 1874. *26, 27, 30, 139, 141, 145.* Cum.: Cummings, Decades of North American Lichens, 1892–1903. I *8,* I *9 a–b,* I *10,* I *11,* I *23,* I *102,* I *106,* I *107,* I *274,* I *352;* II *23,* II *27,* II *86,* II *274.* Cum. Lich. Bor. Am.: Cummings, Williams & Seymour, Lichenes Boreali-Americani, 1894–1903. *85, 165.* Desm. ed. I. Ser. I: Desmazières, Plantes Cryptogames du Nord de la France, 1825–1851. *1940, 1942, 1943.* Desm. ed. II. Ser. I and Ser. II: Desmazières, Plantes Cryptogames de France, 1836–1851. I *1590,* I *1592,* I *1593;* II *586.* Ekart.: Ekart, Kryptogamische Gewächse Koburgs. *8.* Elenk.: Elenkin, Lichenes Florae Rossiae, 1904. *5, 52 a–c, 53 a–c, 54 a–c, 102 a, b, 106 a–b.* Erb.: Erbario Crittogamico Italiano, 1858–1867. I *17,* I *118,* I *119,* I *465,* I *832,* I *931,* I *1221.* Fellm.: Fellman, Lichenes Arctici, 1863. *77, 79, 80, 82, 83.* Flag. Alg.: Flagey, Lichenes Algerienses, 1892. *11.* Flag. Lich. Fr.-C.: Flagey, Lichens de Franche-Comté, 1882–1888. *16, 17, 72, 73.* Flk.: Floerke, Deutsche Lichenen, 1815–1821. *34.* Fl. Hung.: Flora Hungarica Exsiccata, 1913. *19.* E. Fries: Fries, E., Lichenes Sueciae Exsiccati, 1818–1852. *48, 140, 166, 167, 168, 169, 260, 307, 335, 337.* Th. Fries: Fries, Theodor M., Lichenes Scandinaviae, 1859–1865. *6.* Funck: Funck, Cryptogamische Gewächse des Fichtelgebirg's, 1801–1838. I *11,* I *141,* I *374,* I *661;* II *107,* II *108,* II *109,* II *113.* Gar.: Garovaglio, Lichenes Provinciae Comensis et Vallis-Tellinae, 1837–49. I *8.* Harm.: Harmand, Lichenes Gallici Rariores Exsiccati, 1909. *64, 66, 67, 69.* Harm. Lich. Loth.: Harmand, Lichenes in Lotharingia. *258, 278, 288, 289, 294, 297, 313, 315, 319.* Hav.: Havaas, Lichenes Norvegiae Exsiccati, 1901–1914. *78, 153, 179, 180, 181, 182, 222, 223, 251, 252, 314, 325, 390, 444.* Hav. Occid.: Havaas, Lichenes Norvegiae Occidentalis Exsiccati, 1912–1913. *18.* Hepp, Zür.: Hepp, Flechten Zürich. *41.* Howe: Howe, Lichenes Novae Angliae, 1911–1914. *27, 28.* Johns.: Johnson, North of England Lichen-Herbarium, 1894–1910. *23, 66, 67, 69, 221, 303.* Larb. Caes.: Larbalestier, Lichenes Caesarienses et Sargienses Exsiccati, 1867–1869. *17, 64, 65, 66.* Larb.

Herb.: Larbalestier, Lichen-Herbarium, 1879–1881. *86, 124, 211, 291, 293.* Leight.: Leighton, Lichenes Britannici Exsiccati. *76, 203, 365.* Lojk. Hung.: Lojka, Lichenes Regni Hungarici, 1884. *119.* Lojk. Univ.: Lojka, Lichenotheca Universalis. *62, 63, 111, 158.* Malbr.: Malbranche, Lichens de Normandie, 1863. *65, 225, 268, 269, 270, 315, 370.* Malme: Malme, Lichenes Suecici Exsiccati, 1897–1916. *61, 66, 67, 133, 176, 178, 204, 230, 265, 405, 505.* Mand.: Mandon, Lichens de Madère. *11.* Mass.: Massalongo, Lichenes Italici Exsiccati, 1855–1856. *314.* Meresch.: Mereschkowsky, Lichenes Rossiae Exsiccati. *4, 54, 55.* Merr.: Merrill, Lichenes Exsiccati, 1909–1912. *27, 35, 75, 96, 221, 237, 251.* Mig.: Migula, Cryptogamae Germaniae, Austriae et Helvetiae Exsiccatae, 1902–1904. *90.* Moug. et Nest.: Mougeot et Nestler, Stirpes Cryptogamae Vogeso-Rhenanae. *249, 315, 353, 634, 1428.* Mudd.: Mudd, Lichenes Britannici Exsiccati, 1861. *66.* Mus. Krypt. Exs. Vind.: Kryptogamae Exsiccatae editae Museo Palatino Vindobonensi, 1894–1915. *156, 768, 876 a & b, 1046, 1365, 3163.* Norrl. et Nyl.: Norrlin et Nylander, Herbarium Lichenum Fenniae. *26, 27, 202, 209, a, b.* Nyl. Par.: Nylander, Herbarium Lichenum Parisiensium, 1855. *32.* Nyl. Mont-Dor.: Nylander, Lichenes Mont-Dorienses, 1856. *29.* Nyl. Pyr.: Nylander, Lichenes Pyrenaeorum Orientalium, 1872. *17, 54.* Oliv.: Olivier, Herbier des Lichens de l'Orne et du Calvados, 1880–1884. *9, 116, 165, 208.* Picq.: Picquenard, Lichens du Finisterre. *74.* Rab. Cent.: Rabenhorst, Kryptogamische Centurien. *7, 16, 22.* Rab.: Rabenhorst, Lichenes Europaei Exsiccati, 1855–1879. *250, 471, 912.* R. & S.: Reichenbach et Schubert, Lichenes Exsiccati, 1822–1824. *11, 35.* Roum.: Roumeguère, Lichenes Gallici Exsiccati, 1879. *38, 40, 44, 186, 433, 558.* Roum. Gen.: Roumeguère, Genera Lichenum Europaeorum Exsiccatae, 1895. *27.* Salw.: Salwey, Lichenes Centum ex Herbario T. Salwey. *140, 144, 148, 168, 235, 237.* Schaer.: Schaerer, Lichenes Helvetici Exsiccati, 1823–1852. *360, 365, 387.* Schl.: Schliecher, Plantae Cryptogamicae Helvetiae Centuria. *IV 46.* Spruce: Spruce, Lichenes Amazonici et Andini, 1846. *127, 132, 136, 156, 176.* Stenh.: Stenhammar, Lichenes Sueciae Exsiccati. *67, 71, 122, 123, 125, 154, 155, 156.* Trev.: Trevisan, Lichenotheca Veneta, 1869. *156, 267.* Tuck.: Tuckerman, Lichenes Americae Septentrionalis Exsiccati, 1854. *15, 17, 70, 72, 76, 78.* Wain.: Wainio, Lichenes Brasilienses. *106, 400, 538b.* Wartm.: Wartmann, Schenk & Winther, Schweizerische Kryptogamen, 1862–1882. *740, 741.* Welw.: Welwitsch, Cryptotheca Lusitanica, 1842–1850. *75, 77.* West.: Westendorp, Herbier Cryptogamique Belge, 1845–1859. *1041.* Zw.: Zwack-Holzhausen, Lichenes Exsiccati, 1850–1894. *252, 450, 569, 913.*

General Index

Accepted scientific names are in Roman type; synonyms, in *italics;* new names, new combinations and principal references in **bold face** type.

	Page		Page
Borreri furfuracea	136	*Hypogymnia enteromorpha*	50
Collema exasperatum	66	*Imbricaria*	42
Cornicularia pubescens	56	*centrifuga*	68
Evernia americana	136, 137	*conspersa*	72
furfuracea var. *Cladonia*	139	*conspersa* f. *isidiata*	76
kamtschadalis	136, 137	*crinita*	127

diatrypa 43, 44
dubia 90
encausta 53
enteromorpha 50
incurvus 67
olivacea 60
physodes 46
quercina 91
stygia 57
Lichen aspidotus 63
Borreri 88
caperatus 113, 114
centrifugus 68, 72
conspersus 72
diatrypus 43, 44
dubius 90
encaustus 53, 54
furfuraceus 137, 138
incurvus 67
intestinalis 50
laciniatus var. *physodes* 45
laevigatus 109
lanatus 56
olivaceus 59
omphalodes 80
perforatus 130
perlatus 122
pertusus 43, 44
physodes 45
pubescens 56
quercinus 91, 92
saxatilis 82
scorteus 92
stygius 57
tiliaceus 91
Lichenoides furfuraceum 137, 138
Lobaria furfuracea 137, 138
incurva 67
olivacea 59
perlata 122
perlata var. *ciliata* 124
physodes 46
saxatilis 82
stygia 57
terebrata 43
tiliacea 91
Menegazzia 43
physodes 46
Parmelia **41**
acanthifolia 79
ambigua 141
ambigua var. *Halei* 141
americana 136, 137
Amphigymnia (Euparmelia sect.) **112**
Amphigymnia (sect.) 112
arizonica 141
aspidota 63
atrofusca 141
aurulenta **110**
Bolliana **90**
Borreri 79, **88**, 90
Borreri var. *hypomela* 88
Borreri var. *rudecta* 96
camtschadalis f. *americana* 136, 137
Canalicularia (sect.) 135
caperata 55, 112, **113**
caperata var. **incorrupta** 118
caperata var. subglauca **119**
caroliniana **106**
centrifuga 54, **68**
ceratophylla var. *phyllodes* 46
cetrarioides **125**
cetrarioides var. rubescens **127**
cetrata **100**
cetrata var. subisidiosa **101**
chlorochroa **70**, 71
ciliata 124
cirrhata **136**, 137
Cladonia **139**, 140
colpodes 141
conspersa 67, **72**, 78
conspersa var. **isidiata** 76
conspersa f. *isidiata* 76
conspurcata **65**
cribellata 52, 53
crinita **127**
cristifera **129**
cubensis 79, **108**
dubia 90
encausta **53**, 54
endoleuca 67
endoxantha **110**
enteromorpha 45, **50**
erecta **103**

	Page
Euparmelia (subgen.) Hue	**55**
Euparmelia (subgen.) Harm.	42
Everniaeformes (Euparmelia sect.)	135, 136, 141
Everniiformes (subgen.)	135
Everniiformes (sect.)	135
exasperata	**66**
Finkii	**106**
flavicans	121
Frankliniana	141
frondifera	132
furfuracea	135, 136, **137,** 138, 140
Halseyana	141
Herreana	**121**
Herrei	**88**
horrescens	85
Hubrichtii	**102**
Hypogymnia (subgen.)	**45**
Hypotrachyna (Euparmelia sect.)	**79**
Hypotrachyna (sect.)	79
Imbricaria (sect.)	42
incorrupta	118
incurra	**67**
laevigata	**109**
latissima	**134**
leiocarpa	96
leucochlora	**78**
lineola	**77**
livida	**105**
Lobaria (sect.)	42
Lobaria sect. *Imbricaria*	42
lophyrea	**52**
margaritata	141
Melanoparmelia (Euparmelia sect.)	**55**
Melanoparmelia (sect.)	55
Menegazzia (subgen.)	**42**
Michauxiana	124
molliuscula	71
multispora	**64**
Nepalensis	136, 137
olivacea	**59**
olivacea var. aspidota	**63**
olivacea var. *corticola* f. *conspurcata*	65
olivacea var. glabra	**64**
olivacea corticola* var. *glabra*	64
olivacea var. *multispora*	64
olivacea var. *polyspora*	64
olivacea var. *prolixa*	58
olivaria f. *cetrarioides*	125
omphalodes	**80**
perforata	113, **130**
perforata var. hypotropa	**132**
perlata	112, **122**
perlata var. ciliata	**124**
perlata var. *flavicans*	121
perlata f. *rubescens*	127
pertusa	**43**
physodes	**45,** 50, 52, 54
physodes var. *encausta*	53
physodes var. *enteromorpha*	50
physodes var. labrosa	49
physodes var. obscura	49
physodes var. platyphylla	49
physodes var. vittata	49
physodes var. *vulgaris*	46
praesignis	**119**
praetervisa	133
proboscidea	**132**
prolixa	**58,** 59
Pseudevernia (subgen.)	**135,** 136
pubescens	**56,** 58
quercina	**91**
reticulata	**99**
rudecta	79, **96**
rudiata	96
saxatilis	42, 81, **82,** 88
saxatilis var. Anzi	**85**
saxatilis var. *leucochroa*	82
saxatilis var. *omphalodes*	80
sinuosa var. *laevigata*	109
soredica	**120**
sphaerosporella	**71**
stuppea	141
stygia	55, **57**
subglauca	119
sublaevigata	**107**
sublinearis	79
submarginalis	124
subolivacea	60
sulcata	**86**
sulphurosa	**112**
texana	**95**

	Page
tiliacea	91
tiliacea var. *sublaevigata*	107
tiliacea var. *sulphurosa*	112
tinctoria	**133**
vagans	71
villosa	135
Xanthoparmelia (Euparmelia sect.)	**66**
Xanthoparmelia (sect.)	67
Parmotrema	112, 113
Physcia	42
Platisma caperatum	113, 114
perforatum	130
Pseudevernia	135, 141
furfuracea	138
Squamaria stygia	57

Annals
of the
Missouri Botanical Garden

Vol. 28 APRIL, 1941 No. 2

BINARY VARIATION IN TRADESCANTIA BRACTEATA

EDGAR ANDERSON

Geneticist to the Missouri Botanical Garden

Professor in the Henry Shaw School of Botany of Washington University

Although it is peculiarly variable, *Tradescantia bracteata* is ordinarily one of the most distinctive and easily recognized of the dozen or so species which are closely related to *T. virginiana*. In addition to various minor characters, it differs from all these species by its long rhizomes which permit it to grow into large mat-like clones, even in prairie sod. Plants of this species in an experimental garden may spread to a diameter of two or three feet, while in the same period the growth of other species is to be measured by inches, if at all.

In spite of its several distinctive features, *Tradescantia bracteata* is somewhat variable in a peculiar sort of way. If one confines his study to the selections from populations which find their way into herbaria, the variation seems no more extreme or extensive than in the other widespread species of *Tradescantia*. If living populations (or mass collections) are examined, however, it will be found that they vary around two quite different centers which are illustrated in figs. 1 and 2. In the prairie populations which we have studied the bulk of the individuals are more or less similar to Type 'A'. They have unusually vigorous rhizomes and form large clones. The flowering stems are unbranched, and there are usually four

long internodes above the ground level. The leaves are narrow with a peculiar yellowish cast, and the pubescence tends to be very short and scattered. The other center (Type 'B') is made

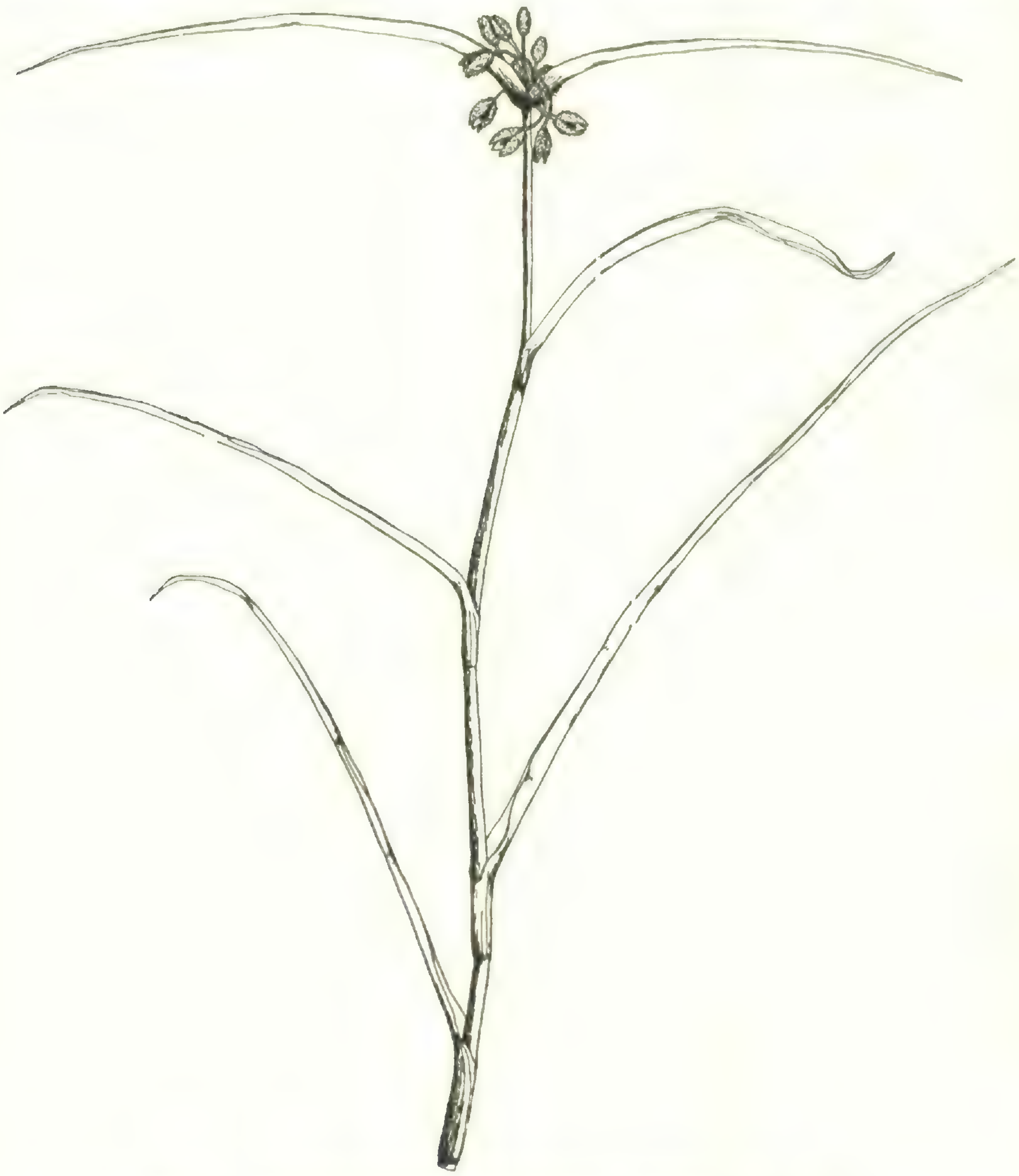


Fig. 1. Habit sketch of *Tradescantia bracteata*, type 'A.'

up of plants which tend to be characterized by broad leaves, fewer nodes to the stem, vigorous secondary branches, and a lesser capacity to spread into large clones. If collections are made only by the tens and twenties these two centers are apt

Fig. 2. Habit sketch of *Tradescantia bracteata*, type 'B.' Figs. 1 and 2 drawn to the same scale by Ruth P. Ownbey, from plants collected at Portage des Sioux, Mo.

to appear, but in every collection of 100 or more plants from the same colony they are certain to be evident.

Tradescantia bracteata is therefore unique among the American Tradescantias because it exhibits extreme *intra-regional* variation. There are other species of *Tradescantia* which show as much variation when collections are made from widely different regions within their ranges, but we have found no other species which varies in this way within single populations.

To analyze this variation, mass collections of *T. bracteata* were made at a number of points. The collection at Portage des Sioux was studied the most intensively since it was nearest the laboratory, but the general features discovered there are similar at the other points where a large population was analyzed. Extremes of the two types illustrated in figs. 1 and 2 were studied carefully, and from them an index was constructed for classifying the entire population with reference to the approach of each individual to these two types. The method was originally worked out for studying hybrid populations of *Tradescantia* (Anderson, '36) and has been found to be generally applicable to such cases. The particular characters used in this index and the values assigned to each are as follows:

Maximum width of floral leaves:
- Over 19 mm. 0
- Under 19 mm. 4

Sepal color:
- Florid 0
- Intermediate 1
- Not florid 2

Stomata (under a hand lens):
- More conspicuous than surrounding cells 0
- Scarcely as conspicuous as surrounding cells 1
- No more conspicuous than surrounding cells 2

Number of elongated internodes on the flowering stems:
- 2 0
- 3 1
- 4 or more 2

Branching of the flowering stem:

Unbranched 2
With sterile branches 1
Branches bearing flowers 0

This index was used in classifying four populations of *T. bracteata,* with broadly similar results in each case (fig. 3), but with significant special features. At each of these localities the species was found to be morphologically duplex. That is to say, that it fluctuated around two different centers, Type 'A' and Type 'B'. That these two types are due to inherent differences in the germplasm and not to environmental or age differences is shown by the fact that transplants have consistently maintained their original type in the experimental garden. Plants moved from various midwestern points to Boston and from the Dakotas to St. Louis have held to their original type over a period of years.

Although connected in each population by a manifold series of intermediates, the extremes when sorted out by means of the index were most surprising. Individually or as a group, the extreme plants of Type 'B' are morphologically very similar to *Tradescantia hirsutiflora* of the Gulf Coast, a species which is today completely unknown within the range of *T. bracteata.*

Tradescantia hirsutiflora (or at least one element in it) is itself so similar to *T. virginiana* that it might almost be considered a geographically localized variety of that species. While the ranges of *T. virginiana* and *T. bracteata* overlap slightly, extreme plants of Type 'B' resemble *T. hirsutiflora* more closely than they do *T. virginiana.*

In any explanation of the binary variation of *T. bracteata,* there are several critical pieces of evidence.

1. While the differences between the two types are manifold, there is enough relationship physiologically between them to suggest that there might be basically a single difference in rhizome vigor, to which all the other differences are secondary. Active rhizomes would produce large clones with many shoots, among which there would be more root competition beneath

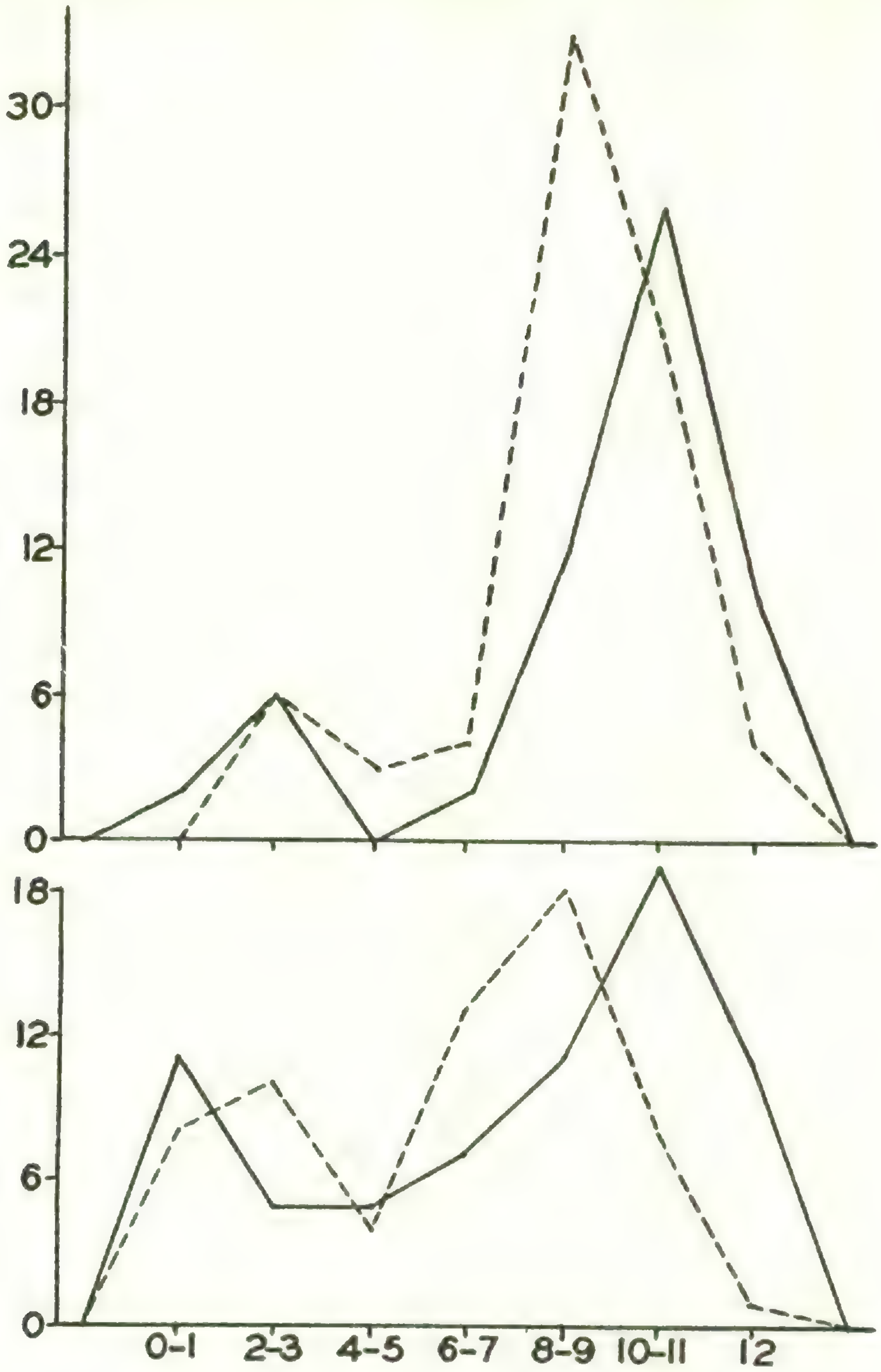


Fig. 3. Frequency diagrams for Index No. 1 of four populations of *T. bracteata*. Upper figure, from plants growing in sod: dotted line, 60 plants from unplowed swamp pastures at Portage des Sioux, Mo.; solid line, 30 plants from prairie swale at Harris's Grove, north of Grinnell, Iowa. Frequencies crudely adjusted by multiplying by 2. Lower figure, two populations from roadways: dotted line, 60 plants along roadway at edge of field, Portage des Sioux, Mo.; solid line, 60 plants from railroad right-of-way and roadway, Victor, Iowa.

the soil and more shading above the soil. It is therefore conceivable that the narrower, less-branched shoots and the narrow leaves and smaller flowers might be merely a secondary consequence of more active rhizomes.

2. Though the differences between the two types might result from a single physiological difference, there is little in the variation to suggest that it is the work of a few genes. The differences are too manifold and the variation of the intermediates resembles the varied recombinations of second-generation species crosses rather than simple Mendelian segregation.

3. The differences are apparently not due to age, since transplants of both types have maintained their original character when brought into experimental gardens. One of the clones which was originally selected because of its remarkable capacity to spread repeated this behavior when transplanted from Iowa to Massachusetts.

4. The peculiar characteristics of Type 'A' are unique in this group of species.

From this evidence we conclude that Type 'A' and Type 'B' owe their differences to segregating elements within the germplasm, to differences of the order of whole chromosomes or of chromosome arms. As to how this variation was introduced into the species we have no evidence. There are at least two very different ways in which it might have occurred. On one view, *Tradescantia bracteata* would originally have been only of Type 'B'; on the other hypothesis, the original element in the species would have been Type 'A'. It may be that the binary condition is as old as the species. On that view, the peculiarities of Type 'A' appeared within the original primitive stock of Type 'B' (by whatever process or group of processes specific differences are achieved in this genus) with the added peculiarity that the original stock tended to be carried along in the population. Quite another hypothesis is suggested by the resemblance of the variation of *T. bracteata* to that which we have studied in species hybrids of *Tradescantia*. On this view, Type 'A' was originally differentiated as a unique species and Type 'B' then originated by hybridization between Type 'A' and *T. hirsutiflora* at a time when the ranges of one

or both of these species were different enough from their present distributions to bring them into contact. If this happened comparatively recently we might expect to find Type 'B' limited to the southern or southeastern extremity of the range of

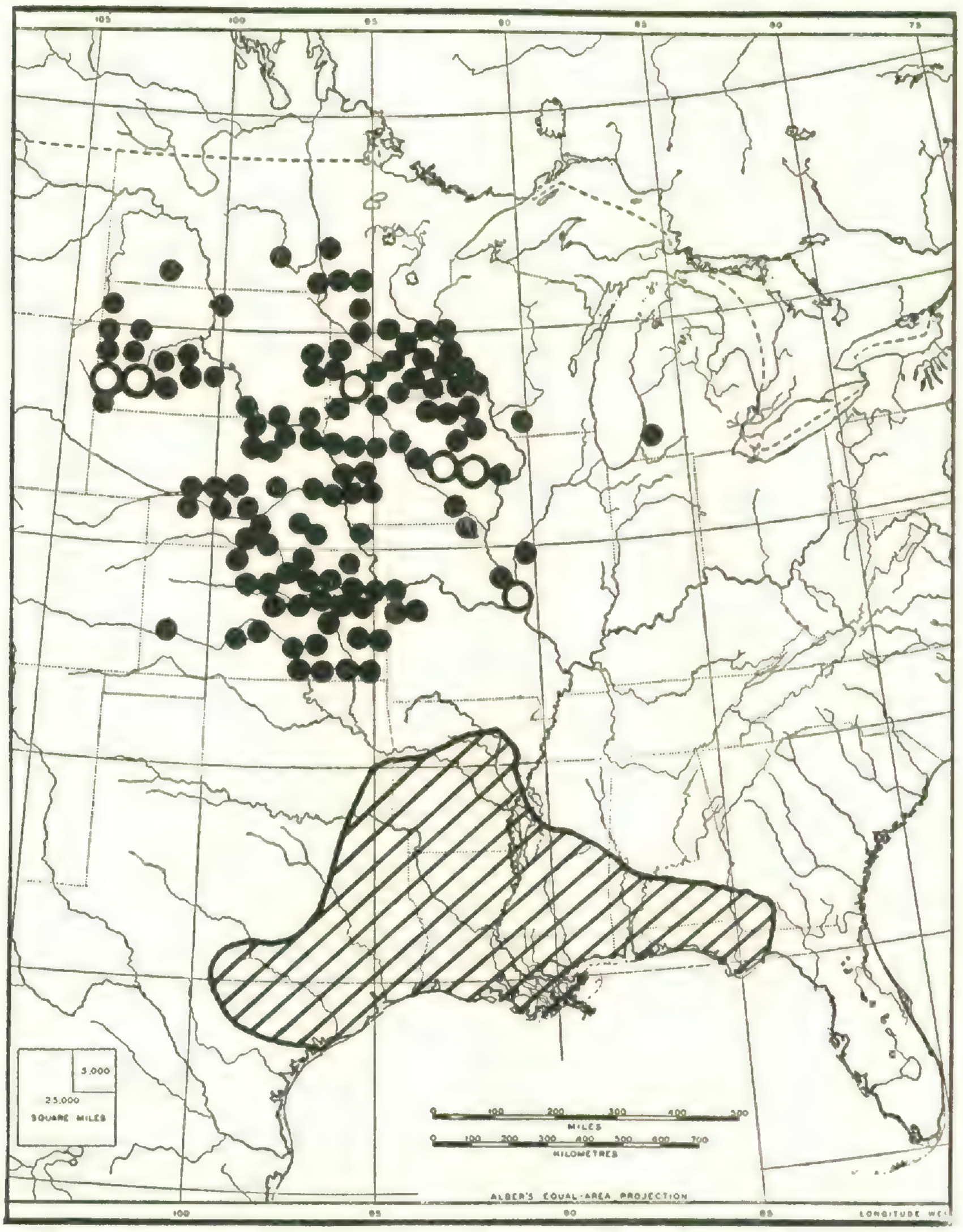


Fig. 4. Map of middle-western United States showing the known distribution of *T. bracteata* (black dots) in relation to that of *T. hirsutiflora* (diagonal lines). Each dot represents an herbarium specimen; open circles, points at which mass collections were made.

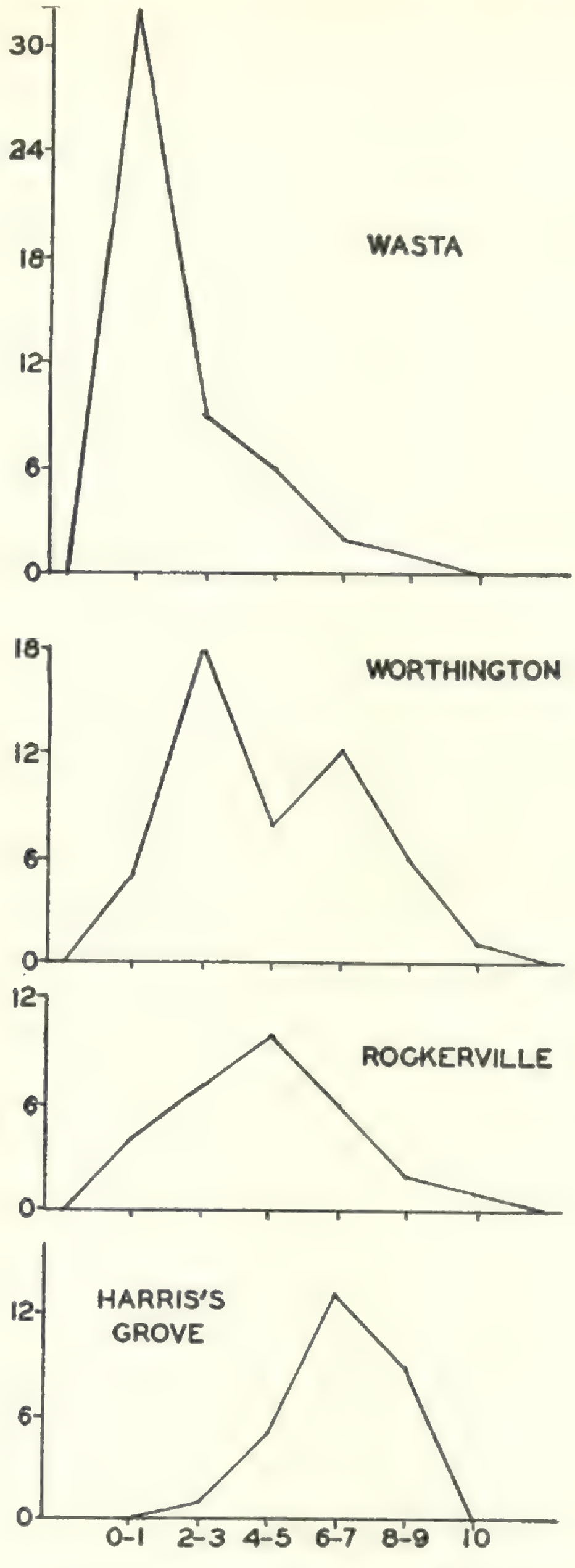


Fig. 5. Frequency diagrams for Index No. 2 of four populations of *T. bracteata*. Populations arranged according to the percentage of open soil in the habitat.

T. bracteata. If, however, the hybridization is a matter of very long standing, then Type 'B' might be expected to occur throughout the range of *T. bracteata.* For determining this point collections from the Black Hills would be particularly significant since they are at the opposite end of the range of *T. bracteata.* Mass collections were accordingly made at the points shown in fig. 4. Frequency distributions for these collections are shown in fig. 5. The index used in deriving the frequencies for fig. 3 could not be used since it was based in part on characters which can be scored only in living material. The following index was therefore constructed for dealing with the pressed material:

Maximum width of floral leaves:
- From mid-vein to margin, over 8 mm. 0
- From mid-vein to margin, 6–7 mm. 1
- From mid-vein to margin, 5 mm. or less 2

Length of hairs on pedicel:
- Over 0.8 mm. 0
- 0.5 to 0.7 mm. 1
- Less than 0.5 mm. 2

Number of elongated internodes on flowering stems:
- 2 0
- 3 1
- 4 or more 2

Branching of the flowering stem:
- Unbranched 2
- With sterile branches 1
- Branches bearing flowers 0

It will be seen that this index differs from that previously used in the following ways: (1) In measuring the maximum width of the floral leaves (bracts) one-half the width rather than the whole width had to be used because the specimens were pressed. This, as well as the changes in drying, increases the percentage of error. (2) The color of the sepals and the character of the stomata could not be ascertained in pressed material. In their place the length of the pubescence of the

pedicel was substituted, since it is prevailingly thick and long in Type 'B' and short and scattered in Type 'A.' It was measured to a tenth of a millimeter, using a camera lucida. The measurement was accurate, but a study of plants in the experimental garden has shown that this character is affected by temperature and humidity. Index No. 2 therefore, while it is more or less similar to Index No. 1, is not as accurate, and since it is based on fewer characters does not separate the two centers as well in the frequency distributions. However, it gives a roughly similar result as will be seen from fig. 6, which shows

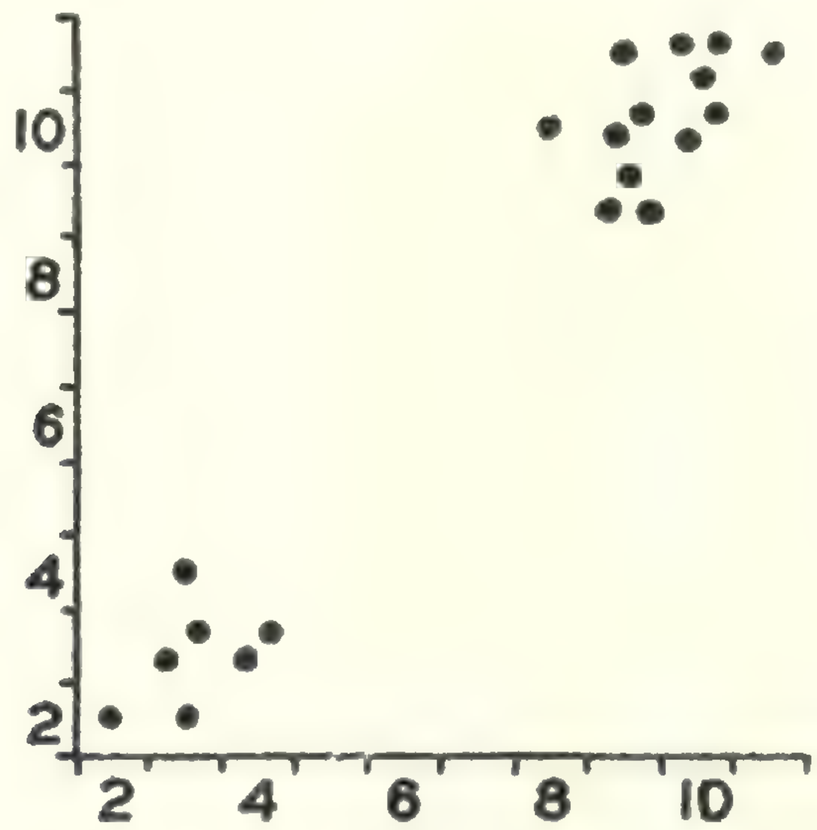


Fig. 6. Correlation between index values of 20 plants from Portage des Sioux as measured by Index No. 1, vertical scale, and Index No. 2, horizontal scale.

the correlation between the two indices for 20 plants which were measured by each index.

Population frequencies for Index No. 2 are graphed in fig. 5. It will be seen that Type 'B' not only occurs in the opposite corner of the range of *T. bracteata* from that which comes closest to the territory of *T. hirsutiflora* but that it even makes up a higher percentage of the population than it does in the south. This is perhaps correlated with open-soil habitats and is discussed below on page 159. The curves are also less bimodal than in the Missouri and Iowa populations. This is in part due to the inferiority of the index but probably also re-

flects a real difference in the northwestern populations. However, although plants of Type 'A' were not present in large enough numbers to produce a bimodal curve, at least a few were encountered at every locality as well as various intermediates. Type 'B' therefore most probably originated before *T. bracteata* moved into the territory it now occupies. The entire group of species to which it belongs is centered upon the Edwards Plateau in east-central Texas. It is quite possible that at one time *Tradescantia bracteata* grew within this same general area and could then have differentiated from, or hybridized with, *T. hirsutiflora.* This latter species still occurs there and is the most aggressive species in that area and the one most apt to hybridize with other species.

To summarize: Associated with typical *Tradescantia bracteata* throughout its range and connected with it by a manifold series of intermediates is a *Tradescantia* morphologically very similar to *T. hirsutiflora,* a species of the Gulf Coastal Plain. It is suggested that this variant originated by partial differentiation from, or hybridization with, *T. hirsutiflora* at a time when the two species were in closer contact than now, and presumably before *T. bracteata* moved into the territory it now occupies. Since the chief effect of the phenomenon is to produce a species which fluctuates around two centers, instead of one, we are calling it *binary variation.*

There now remains to discuss:

(1) Its selective advantages.
(2) The cytology of *T. bracteata.*
(3) Its probable occurrence in other groups of organisms.

(1) *The selective advantages of binary variation.*—As will be seen from the map in fig. 4, *Tradescantia bracteata* is a species of the prairies and northern great plains. This region is notorious for a climate which fluctuates widely from decade to decade as well as from year to year, and within that area *Tradescantia bracteata* is most commonly found in marginal habitats which are peculiarly susceptible to climatic fluctuations. In the prairie states it grows at the edges of swales or in slight depressions which are just damp enough to discourage

some of the prairie grasses. A single dry year has a marked effect upon the vegetation. In a fluctuating climate, in such a habitat, a species which varies around two centers would be at a great selective advantage, particularly if the permanence of the two-centered condition was assured by some cytogenetic mechanism. In this connection the frequency curves of fig. 3 are rather suggestive since they demonstrate that with a slight change in habitat there are changes in the proportions of Type 'B'. Two populations were studied in Missouri and two in Iowa. In each case one of the populations was from a more or less natural prairie and the other was from a man-made habitat. At Portage des Sioux, Missouri, in rich bottomland near the junction of the Mississippi and Missouri rivers, is a low grassy pasture which is apparently a remnant of one of the river-bottom savannahs once common to the region. One collection was made in the pasture and another along a cart track which ran beside it. Of the Iowa collections, one was from the edges of a grassy swale in an unplowed pasture and the other from along a railroad track adjacent to rich bottomland, all of which was under cultivation. It will be seen that the curves of the two prairie habitats are very similar, as are also those of the two trackways, but that the proportion of Type 'B' is much higher in the open-soil habitats, so much so that the make-up of the species differed much more markedly between neighboring habitats than it did between Missouri and Iowa, for the same habitat.

This impression is confirmed by the frequencies for Index No. 2, diagrammed in fig. 5, where they are arranged from above to below according to the prevalence of grass at each locality. At Wasta, North Dakota, there was practically no grass, and many of the plants of *T. bracteata* were growing in soil as open as if they had been cultivated in a garden. At Harris's Grove, the other extreme, the plants were growing in dense prairie sod and were so overtopped by the grass that they were hard to find. The frequency diagrams show that the grassier the habitat, the greater the percentage of Type 'A' and intermediates resembling it. This is not surprising since in at least two ways Type 'A' is evidently better adapted to such an en-

vironment. In the first place, its longer, more numerous internodes allow it to compete for sunlight with the grasses in situations where plants of Type 'B' would be completely submerged. In the second place, its extremely active rhizomes would allow it to compete with the notoriously vigorous rhizomes of the prairie grasses.

(2) *The cytology of T. bracteata.*—*Tradescantia bracteata* is prevailingly diploid, with 6 pairs of chromosomes. Table I lists the chromosome determinations which have been made as well as those previously listed by Anderson and Sax ('36) and summarizes the total frequencies. The species is overwhelmingly diploid, although polyploid individuals have been collected in nature at two points. It is therefore unlike all the other widespread species closely related to *T. virginiana,* since they are either known only as tetraploids or have diploid races confined to a relatively small area. There are other diploid species in this group but, without exception, they are of very limited distribution and several of them are on the verge of extinction. In our opinion diploidy has persisted in *T. bracteata* because it is actually at a selective advantage in prairie habitats by reason of its effect upon the flowering season. Like many other prairie plants, *Tradescantia bracteata* dies down rapidly after it has flowered and spends the summer in a dormant or semi-dormant condition. In an experimental garden

TABLE I

CHROMOSOME NUMBERS OF PLANTS OF *T. BRACTEATA* COLLECTED IN THE WILD

Localities	2n	3n	4n	Localities	2n	3n	4n
Houlton, Wisconsin	1			St. Louis, Missouri	1		
Preston, Minnesota	1			Huron, South Dakota	1		
Rock Co., Minnesota	1			Kennebec, S. Dak.	1		
Worthington, Minn.	1			Murdo, S. Dak.	1		
Grinnell, Iowa	3	2		Rockerville, S. Dak.	1		
Kellogg, Iowa	1			Wind Cave, S. Dak.	1		
Kendallville, Iowa	1			Wasta, S. Dak.	2		
Pierson, Iowa	1			Overton, Nebraska	1		
Tama, Iowa	3			Royal, Nebraska	1		
Victor, Iowa	1			Lawrence, Kansas			2
Portage des Sioux, Missouri	8			Manhattan, Kansas	3		

it withers so quickly that one who did not know the species would assume that the plants were badly diseased. Tetraploidy would be disadvantageous to such a species since it favors longer flowering seasons. In nature, in the experimental garden, and in the greenhouse, tetraploid Tradescantias differ from their related diploids, among other things, by the greater length of their blooming periods. Polyploid strains, such as the plants reported in Table 1, would be at a selective disadvantage since they would come into flower more slowly and carry their flowering into the unfavorable drought and heat of the summer months. The two tetraploid plants reported above were discovered under precisely those circumstances. When originally collected they were the only plants still in flower at that locality, all the neighboring plants having withered and died down.

Aside from the gross information concerning chromosome number, little is known with regard to the cytology of *T. bracteata*. Sax ('37) and Darlington ('37) have reported inversions in this species, and Swanson ('40), from these facts and his own evidence, has concluded that the occurrence of inversions in *Tradescantia* is very widespread.

The fact that both Type 'A' and Type 'B' have been found in every population which has been examined leads us to suspect that the binary condition is being maintained by some fairly precise cytogenetic mechanism. Otherwise it is difficult to see how both varieties could be present in every population. There must at least be some mechanism by which plants which are phenotypically like one variety can yield offspring resembling the other when they are intercrossed. One would need to postulate no more intricate mechanism than those already demonstrated for cereal rogues or the complexes of *Oenothera*.

Although the morphological differences between the two species seem to be manifold, it is possible, as we have pointed out above, that only a small proportion of the germplasm is responsible for the change. Given the basic difference in rhizome growth, many of the other differences might automatically follow. A large matted clone with many flowering stems might be expected to have narrower leaves and less sec-

ondary branches than an isolated plant such as Type 'B,' with only a few flowering stems. If only one or two chromosome segments are responsible for the bulk of the differences between the two varieties it would be comparatively easy for the binary condition to be maintained.

(3) *Probable occurrence of binary variation in other groups of organisms.*—Binary variation, in our opinion, is probably fairly widespread in both the plant and animal kingdoms. Its frequency can scarcely be discussed until more species have been examined by populations. Up to the present not more than a handful of species has been studied in this way. Certain of the Drosophilae studied by Dobzhansky, Spencer, Patterson, and their students are perhaps to be classified in this category though data with regard to populations are still too meagre to permit a definite opinion. The relationship between the black and white races in the southeastern United States is very similar and differs only in the fact that there are numerous communities which fluctuate around only one center and that the chief isolating factor (social prejudice) has caused nearly all the intermediates to be classified as black instead of being recognized as intermediates.

Among the higher plants binary variation probably occurs fairly frequently within a part of the range of widespread species, but cases such as *T. bracteata* where a species is binary throughout its range are probably rare. In eastern North America many, if not most, of the deciduous trees which are relatively uniform in the North and East include other elements within their populations in the Ozarks and the Southwest. *Acer saccharum,* for instance, forms relatively uniform populations to the northeast, while in the Ozarks usually it includes the variety *Schneckii* and is united with it in that region by a series of intermediates.

SUMMARY

1. Associated with typical *Tradescantia bracteata* throughout its range and connected with it by a manifold series of intermediates is a *Tradescantia* morphologically similar to *T. hirsutiflora.*

2. It is suggested that this variant originated by partial differentiation from, or hybridization with, the *T. hirsutiflora-virginiana* stock at a time when the ranges of these Tradescantias were confluent.

3. The phenomenon is named "binary variation." Its selective advantages and probable occurrence in other species are discussed.

4. The cytology of *Tradescantia bracteata* is discussed. It is suggested that the exceptional maintenance of widespread diploidy in this species is due to the fact that in a prairie and great-plains environment the shorter blooming season of the diploids may be at a selective advantage.

BIBLIOGRAPHY

Anderson, Edgar (1936). Hybridization in American Tradescantias. I. A method for measuring species hybrids. II. Hybridization between *T. virginiana* and *T. canaliculata.* Ann. Mo. Bot. Gard. **23**: 511–525.

————, and Karl Sax (1936). A cytological monograph of the American species of *Tradescantia.* Bot. Gaz. **97**: 433–476.

Darlington, C. D. (1937). Chromosome behaviour and structural hybridity in the Tradescantiae. II. Jour. Genet. **35**: 259–280.

Sax, Karl (1937). Chromosome behavior and nuclear development in *Tradescantia.* Genetics **22**: 523–533.

Swanson, Carl R. (1940). The distribution of inversions in *Tradescantia.* Genetics **25**: 438–465.

ON THE FLORA OF THE FRONTIER FORMATION OF SOUTHWESTERN WYOMING[1]

HENRY N. ANDREWS

Instructor, Henry Shaw School of Botany of Washington University

AND CORTLAND S. PEARSALL

Geologist to the Tunnel Division, Metropolitan Water Commission, Boston, Mass.

Introduction

In 1917 Dr. F. H. Knowlton described a small flora from the Upper Cretaceous Frontier formation of southwestern Wyoming. Attracted by that author's figures of *Microtaenia paucifolia* (Hall) Knowlton, we made a small collection of the fructifications in the summer of 1934. Nothing of exceptional note was obtained at that time and our collections did not receive immediate study. In the summer of 1939, when the senior author revisited the locality, certain undescribed fructifications were discovered, but as time did not permit extensive exploration we returned the following summer and prospected the outcrop carefully for about 4 miles north and 1½ miles south of Little Muddy Creek. We were fortunate in obtaining nearly complete fertile pinnae referable to *Anemia Fremonti* Knowlton and in finding certain other fossil plants or parts thereof not previously described.

The plant-bearing horizon was originally discovered by Capt. John C. Fremont in 1843 while exploring for a better emigrant route to the Northwest. Fremont's collections were turned over to James Hall, New York State Paleontologist, who published descriptions in 1845. Other collections were made at later dates by members of the U. S. Geological Survey and were presented in Knowlton's paper of 1917.

Of the 25 described species composing the flora there are 7 ferns, 1 *Equisetum,* and 17 Angiosperms, the latter including *Quercus, Ficus, Salix, Aralia, Dewalquea* and *Cinnamomum.*

[1] A study financed in part by a grant from the Penrose Fund of the American Philosophical Society of Philadelphia.

Issued April 28, 1941.

Certain of these genera are undoubtedly valid; others are questionable as Knowlton himself admitted. The present paper will not be concerned with the Angiosperm element of the flora.

GEOLOGY

The section of the Frontier formation discussed in this paper is situated in the southwestern corner of Wyoming, about 15 miles south of the town of Kemmerer, in the vicinity of Cumberland Gap. The formation, which consists of a series of light-colored coal-bearing sandstones and shales approximately 2500 feet thick, extends for many miles both north and south of Cumberland Gap and is characterized by a series of prominent hogbacks. It is underlain by the dark-colored oil-bearing Aspen shales, and overlain by the dark-colored Hilliard shales. The most prominent hogback is formed by the Oyster Ridge member, which is an oyster *(Ostrea soleniscus)*-bearing sandstone about 200 feet thick near the top of the formation. Numerous coal seams are contained in the lower half of the formation.

The plant material was collected from a series of white to light blue-gray shales about 50 feet thick. These are located stratigraphically about 75 feet above the generally accepted base of the formation. Small sandstone beds directly above the plant-bearing shales contain a great deal of silicified wood. The plant shales break poorly along the bedding plane and are in the nature of argillite which in thin section is a typical clastic, fine-grained sediment consisting of approximately 70 per cent clay minerals, 28 per cent angular quartz, 1 per cent feldspar, 1 per cent zircon, hornblende, biotite and carbonate (Veatch, '07).

METHODS

The cellulose transfer technique proved very satisfactory with the compressions of the fertile pinnae of *Anemia Fremonti* (see p. 168). Fragmentary specimens were selected in which the fructifications appeared to be well preserved. A

rather heavy coat of nitrocellulose solution (Darrah's formula) was then applied to the surface of the matrix and exposed plant material. The entire specimen was then placed in hydrofluoric acid. It was found advisable not to cut away the apparently excess rock in back of the compression because in some cases this contained additional fragments of the fructifications which dissolve away from the rock and serve as excellent material for maceration.

The disintegration of the rock can be accelerated by removing the block from the acid each day and scraping away the partially dissolved matrix. Specimens as thick as 1½ inches were treated in this way, and the time for complete dissolution

TABLE I

GEOLOGIC COLUMN SHOWING THE RELATION OF THE FRONTIER FORMATION TO OTHER CRETACEOUS FORMATIONS (FROM VEATCH, '07, TABLE FACING p. 501)

System and Group			Formation
Eocene			Unconformity
Cretaceous		Lower Laramie	Adaville formation, with basal Lazeart sandstone
		Montana	Hilliard formation
	Colorado	Niobrara	
		Benton	Frontier formation with the Oyster Ridge sandstone member
			Aspen formation
		Bear River, Dakota?, and Lower Cretaceous?	Bear River formation
			Beckwith formation
Jurassic			Twin Creek formation

of the rock was in no case longer than 10 days. The last fragments of matrix may be removed with a camel's-hair brush under water. This transparent celloidin technique had, with our material, two very important advantages: first, the back side of the fossil may be studied as well as the front when it is mounted; and second, much better photographs could be obtained than when the rather grayish rock matrix constituted the background. If figs. 2 or 3 (photographs of specimens in the matrix) be compared with figs. 1 and 5 (photographs of specimens transferred to celloidin) the difference is quite apparent.

Maceration of the isolated fragments of the fructifications was done in the usual way with strong nitric acid and potassium chlorate.

SCHIZAEACEAE

Anemia Fremonti Knowlton forma **fertilis** Andrews, forma nov.

It is not often that well-preserved spore-bearing parts can be referred with certainty to any of the numerous sterile fern species that go to compose the fossil record. Associated with foliage which Knowlton ('17) described as *A. Fremonti* were found fructifications of an undoubted schizaeaceous nature and, as will be made clear, in all probability referable to the genus *Anemia*. The significance of the association of fertile and sterile parts will be considered after the former have been described.

The most complete specimen that we have found is shown in fig. 3. It is pinnately compound, the branching taking place in one plane. Figures 1, 2, 4, 5 are isolated primary branches (as will be shown below, these are secondary pinnae, according to usual fern terminology) photographed at a higher magnification. The secondary branches, which are quite short, bear two or three flattened globose bodies, two being borne laterally and a third terminating the branch. In figs. 2 and 5 only one of these bodies may be seen attached to each secondary branch; in fig. 4 two may be seen on some branches while others have only one, both the terminal and a lateral having been lost.

Well-preserved fragments of the primary branches isolated from the matrix show three in all cases.

Within one minute after such fragments had been treated with strong nitric acid and potassium chlorate each of the small black bodies opened up into about seven "valves." If maceration was not then stopped by diluting the acid with water, the fragments very soon almost completely disintegrated. Due to the extreme fragility of the material at this point it has not been possible to prepare permanent preparations nor to obtain satisfactory photographs. Figure 36 shows a secondary branch with its three "bodies" opened out. The segments referred to as valves are in fact pinnules and bear sporangia on their inner surface.

In only one or two cases has it been possible to detect the segmented (pinnular) nature of the globose bodies prior to maceration. The separation of the individual pinnules upon maceration is, however, always uniform and can in no wise be attributed to a maceration artifact. In only two instances have all of the sporangia been observed in place on a pinnule, one of which is shown in fig. 38. The sporangia are arranged in two rows, forming the typical monangial sori of the Schizaeaceae. No evidence of an indusium has been observed. Upon further maceration the sporangia go almost completely to pieces. The maceration residue, however, reveals two structures of considerable interest, spores and more or less complete annuli.

The spores (figs. 6–12) are beautifully preserved, the entire exine being sculptured with characteristic ridges. These are well brought out in the photographs of opposite sides of the same spore (figs. 7 and 8). The triradiate commissure is well defined. Of 50 particularly well-preserved spores that were measured, the average diameter was found to be 40 μ. There is, however, considerable range in size of the spores (from 25 to 47 μ in diameter), as may be noted from the figures where all are shown at the same magnification.

The annuli are also abundant in the residue, the rest of the sporangia disintegrating almost completely. Due to their opaque nature the annuli (fig. 33) are not the best of photo-

graphic subjects and are always split open, apparently along the stomium.

It may be seen then that the structures referred to above as primary and secondary branches are, according to usual fern terminology, secondary and tertiary pinnae, and the sporangia are borne on the under-surface of the ultimate divisions or pinnules. The structure of the pinnules, arrangement of the sporangia, nature of the annulus, and characteristic sculpturing of the spores leave no doubt as to the schizaeaceous affinities of the fossil, and of the four living genera of the family, it is clearly more closely related to *Anemia* than any of the other three. The specimen shown in fig. 3 is comparable in every respect with one of the two basal fertile pinnae characteristic of the species of that genus.

The authors are well aware of the inadvisability in general of placing great weight on the association of isolated parts of fossil plants. In this case, however, the above-described fructifications were found associated with, and only with, the foliage described by Knowlton as *Anemia Fremonti* (figs. 35, 39). The two were found together at three different points between ¼ and ½ mile south of Little Muddy Creek. A comparison of the sterile frond (fig. 39) with certain living species such as *Anemia adiantifolia* Swartz in itself leaves little doubt as to the validity of Knowlton's generic identification. This similarity, combined with our discovery of fertile pinnae whose characteristics clearly point to the same genus and which are constantly associated with the foliage, stands as a credit to Knowlton's original identification and seems to render superfluous a new specific name for the fertile specimens.

The evidence at hand strongly supports the supposition that these sterile and fertile parts are one and the same species, but in view of the lack of organic connection it is advisable to employ some sort of nomenclatorial segregation. To assign a new specific name to the fertile parts tends to defeat rather than enhance the ideals of such an investigation, and, moreover, implies a distinction that the available evidence does not support. In accordance with the remaining element of doubt we

propose to designate the fertile specimens as a distinct form, namely forma *fertilis*. The problem of interpreting the association of scattered parts of fossil plants is one that the paleobotanist frequently encounters, and it is probably true that most workers are inclined to place too much weight upon such associations. We believe that the procedure employed here does not exaggerate the truth yet does reflect the implications that the evidence affords.

It has been assumed in the restoration (fig. 40) that the specimen shown in fig. 3 is a nearly complete fertile pinna and that the pinnae were borne in pairs as in the modern species. It is quite certain that fig. 3 represents a fairly young pinna since fragments of comparable size when macerated still contained large quantities of spores; furthermore other pinnae have been found, a single secondary one being shown in fig. 4, in which the whole has elongated considerably.

The largest fragment of foliage that we have found is shown in fig. 39. This and numerous other specimens served as the basis of the restoration of the sterile portion of the frond. It may be that the lower sterile pinnae were more deeply dissected than is actually represented.

Fossil history of the Schizaeaceae.—

Our knowledge of the earliest members of the Schizaeaceae has been considerably augmented by the recent researches of Radforth ('38, '39). He has shown that *Dactylotheca Sturi* Sterzel and *D. plumosa* Artis are actually annulate and consequently referable to *Senftenbergia*. There has, in the past, been some doubt as to the affinities of that genus but Radforth's investigations leave no doubt as to its proper inclusion in the Schizaeaceae.

The discovery that *Senftenbergia (Dactylotheca) Sturi* has annulate sporangia extends the history of the family back into Lower Carboniferous (Carboniferous Limestone Series) times. The apical annulus consists of a single row of cells in the modern genera *Anemia, Schizaea* and *Lygonium*. However, Radforth has shown that *Senftenbergia pinnaeformis*, an Upper Carboniferous form, had an annulus of two rows of

cells, while *S. Sturi,* from the Lower Carboniferous, has a less regular annulus 4 to 5 cells deep. Of particular interest to the present discussion is his conclusion "that a close phylogenetic relationship exists between these fossil Schizaeaceae and the living Schizaeaceae, and of the latter, particularly the genus *Aneimia.*"

In Jurassic rocks the genus *Klukia* is an undoubted representative of the family and seems to have been rather widespread, specimens having been reported from Yorkshire, Poland, Caucasia and Korea (?).

From the Lower Cretaceous of Virginia, Berry ('11) has described a fertile frond under the name of *Schizaeopsis expansa* (Font.) Berry. This fossil is rather closely comparable to living species such as *Schizaea elegans,* judging from the general morphology of the frond and the sculpturing of the spores.

Stopes and Fujii ('10) described a schizaeaceous fern, *Schizaeopteris mesozoica,* from the Cretaceous of Japan which seems closest to *Anemia.*

Much just criticism has been aimed at the determination of fossil plants based on sterile material but confirmation of Knowlton's identification of *Anemia Fremonti* indicates that even with sterile foliage all is not guesswork. In view of this confirmation in the case of the Frontier formation species we have checked through Knowlton's ('19) list of supposed species of *Anemia* from America. Judging from the published figures there is a reasonable degree of certainty that the following are correctly referred to that genus:

Anemia elongata (Newberry) Knowlton—
Laramie formation, uppermost Cretaceous: Erie, Colo. (?), Point of Rocks, Wyo. (?). (Knowlton, F. H., U. S. Geol. Surv. Prof. Paper 130: *pl. 2, fig. 2.* 1922).

Aneimia eocenica Berry—
Lagrange formation, basal Eocene: Puryear, Tenn. (Berry, E. W., U. S. Geol. Surv. Prof. Paper 91: *pl. 10, fig. 2, pl. 11, figs. 1, 2.* 1916).

Anemia hesperia Knowlton—
Fruitland formation, Upper Cretaceous: San Juan Co., N. M. (Knowlton, F. H., U. S. Geol. Surv. Prof. Paper 98: *pl. 84, fig. 3.* 1916).

Anemia occidentalis Knowlton—
Raton formation, Paleocene: Trinidad, Colo., Yankee, N. M. (Knowlton, F. H., U. S. Geol. Surv. Prof. Paper 101: *pl. 54, fig. 2.* 1917).

Anemia supercretacea Hollick—
Vermejo formation, Upper Cretaceous: Rockvale, Colo. (Knowlton, F. H., U. S. Geol. Surv. Prof. Paper 101: *pl. 30, fig. 5.* 1917).

It is thus clear that the family Schizaeaceae, and particularly the genus *Anemia,* once enjoyed a much more northerly distribution than at present. *Anemia* is now confined to the American tropics and subtropics (with the exception of one species from South Africa), extending northward only into the southern part of the United States.

Anemia sp.

Fragments of fronds have been found at a number of points along the outcrop, which are closely comparable with certain living species of *Anemia.* Although similar in certain respects to *A. Fremonti* they are much less robust and have not been found associated with the fertile pinnae of the latter.

The most complete specimens that we have discovered are shown in figs. 30–32, 34. Those shown in the first two figures probably represent nearly complete fronds which are characterized by a rather long slender stalk, twice pinnate, with a tendency toward a tertiary division in the basal pinnae (fig. 31). It is quite possible that these fronds are simply small specimens of *A. Fremonti* but since they have not been found closely associated with that species it seems best to describe them separately. There is, moreover, a striking similarity to the Wealden fern, *Ruffordia Goepperti,* which Seward ('94) likewise includes in the Schizaeaceae.

GLEICHENIACEAE

Gleichenites coloradensis (Knowlton) Andrews, n. comb.

Dryopteris coloradensis Knowlton, U. S. Geol. Surv. Prof. Paper 108-F: 83, *pl. 30, figs. 3, 4.* 1917.

This apparent fern was included by Knowlton in the Polypodiaceae, a justifiable conclusion considering the fragments of foliage that he had available for study. Although our specimens do not bear reproductive structures, a considerable amount of information has been obtained concerning the structure of the frond as a whole. As may be judged from the following description, it is strikingly similar vegetatively to certain species of *Gleichenia,* the resemblance being sufficiently great to warrant its transference from *Dryopteris* to the genus *Gleichenites* of Goeppert.

Collections were made at three localities along the plant-bearing outcrop, at points approximately 1½, 1¾ and 2 miles north of Little Muddy Creek. Most of our material came from the last two localities where it occurred as a "pure stand," there being no other associated fossil plants.

Knowlton did recognize that it was a plant of considerable size. He writes, "From the presence of large pieces of stems intermingled with the fronds and presumed to belong to them, it is assumed that this fern was probably of large size, but the direct evidence is only sufficient to say that it is at least bipinnatifid." In all probability the "large pieces of stems" that Knowlton mentions are fragments of the rachis. The most distinctive feature of the frond lies in its successive trichotomous-like branchings. The rachis is of considerable size, as may be noted in figs. 20 and 26, a number of fragments similar to that shown in fig. 26 having been found. The central member of the "trichotomy" may grow out (fig. 20) or remain abortive (figs. 21, 24), but it does seem to have been more generally developed in the fossil than in living species such as *Gleichenia pectinata.*

In the reconstruction of the frond in fig. 21 it has been assumed that *c* corresponds to the primary subdivisions of the specimens shown in figs. 20 and 26. The specimen shows three

further divisions, the last of which lies on the counterpart of the specimen and is shown at *b*, fig. 22 (the negative has been reversed so as to show it in the same orientation as fig. 21). The pinnules are arranged on the ultimate (fourth order) subdivisions as shown in figs. 24, 27. Figure 29 has been included to show more clearly the typical pinnule morphology.

The removal of this species from the genus *Dryopteris* seems fully justifiable in view of our present knowledge of the structure of the frond. Had Knowlton had more complete specimens he would undoubtedly have placed it in the Gleicheniaceae. Because of the fact that sporangia still remain to be discovered it seems best to refer the plant to *Gleichenites*.

Of the various species of *Gleichenites* that have been described (Hirmer, '27, pp. 623–4), *G. coloradensis* compares most closely with *G. Gieseckiana* Heer. The characteristic mode of branching, as well as the morphology of the pinnules, is very similar to specimens of the latter described by Seward ('26) from the Cretaceous of Greenland. It was apparently a widespread species during Cretaceous times, specimens having been reported from Spitsbergen, England, France, Germany, Russia, Sakhalin (Japan), Dakota and New Jersey (Seward, '26, p. 147). In view of this circumpolar distribution of *G. Gieseckiana,* it is not surprising to find the very similar, if not identical, *G. coloradensis* in the Upper Cretaceous of southwestern Wyoming.

Where reconstructions of fossil plants or parts thereof can be prepared with a reasonable degree of accuracy it seems desirable that the plant be presented in that fashion. The figured specimens, as well as numerous others from which information has been drawn, bear out the accuracy of our restoration of the frond as we believe it appeared in life (fig. 41). Whether or not the entire frond is represented is, of course, not certain. As our material indicates but four orders of branching, only that many have been shown, and since no rachis fragments larger than those shown in figs. 20 and 26 have been found it is likely that the entire frond is represented. Some of the terminal branches have been eliminated in the restoration in

order that the structure of the terminal pinnae might be brought out more clearly.

The distinctive morphology of the fronds, as well as the sori and sporangia of *Gleichenia,* has enabled its scattered fossil remains to be assembled into one of the most interesting stories of geographical distribution presented by an extant genus. Confined now to the tropics and sub-tropics, *Gleichenia* once enjoyed a range far north of its present confines. It has been described from Jurassic and Cretaceous rocks of Greenland, and from the Cretaceous period numerous localities in North America, to mention a few: Maryland, New Jersey, Kansas, Colorado, Wyoming, California, British Columbia.

In 1935 Seward wrote, "The sight of well preserved fronds of Ferns with forked arms exposed on a slab of shale on the beach of Upernivik Island (71° N. lat.) took me back to a hillside above Penang in the Malay Peninsula, where living Gleichenias in company with *Dipteris* formed a wonderful tangled carpet of luxuriant growth on the edge of a tropical forest." No more striking contrast to either the arctic or tropical climates could be found than the present semi-desert sagebrush hills of southwestern Wyoming whose climate must have been much more like that of Penang in Upper Cretaceous times than it is at present.

CYATHEACEAE-DICKSONIACEAE

Microtaenia Knowlton

In his account of the Frontier flora Knowlton described two species under this genus, *M. variabilis* and *M. paucifolia* (Hall). In both cases apparently fertile fronds were described and figured but no actual evidence of their fertility was given. As we have succeeded in isolating spores from both species a further account of these interesting ferns is presented here.

Microtaenia paucifolia (Hall) Knowlton, U. S. Geol. Surv. Prof. Paper 108-F: 82–83, *pl. 30, figs. 1, 2.* 1917.

Fertile fragments of this species were found to be fairly abundant, particularly within a radius of ½ mile to the north and south of Little Muddy Creek. The greatest part of the

fragments apparently had matured previous to fossilization since of the numerous ones collected only two have yielded spores. The largest specimen (fig. 16) was deposited before spore dispersal as spores have been found in all of the sori studied. When the large globose bodies terminating the pinnules were removed from the rock and macerated in nitric acid and potassium chlorate for a few minutes, a residue of spores resulted (fig. 17). The triradiate commissure is clearly shown. The exine is rather delicate and smooth, with no evidence of sculpturing of any sort. All the spores are distinctly triangular as shown in the figure, and although this may be due in part to collapse it may represent the actual shape of the spore in life. There is very little variation in spore size, all being about 26 μ in diameter.

No evidences of sporangia have been found in the globose terminal supposed sori. There remains the possibility that the "sori" are actually single terminal sporangia. There is a striking resemblance of these structures to the Jurassic genus *Coniopteris,* particularly of *C. hymenophylloides* (see Thomas, '11, *pl. 3, figs. 1, 4, 5;* Seward, '00, *pl. 17, fig. 8).* However, no foliage has been found in the Frontier formation which compares at all closely with that of *Coniopteris.* Because of the close similarity between *Microtaenia paucifolia* and the fertile pinnae of *Coniopteris hymenophylloides,* which is generally accepted as being referable to the Dicksoniaceae, it seems advisable to include *Microtaenia* within that family instead of the Polypodiaceae following Knowlton's classification.

Microtaenia variabilis Knowlton

Only two fertile fragments of this plant are included in our collection. Figure 13 shows one of these magnified nearly 5 times and fig. 14 is a portion magnified 24 times. It differs from *M. paucifolia* in the broader, more leaf-like nature of the pinnae. In fig. 14 a single vein may be seen passing out to each sorus.

Sporangia have not been observed but a few spores have been obtained. Their walls are delicate and wrinkled (fig. 15)

and there is no evidence of sculpturing or a triradiate commissure.

EQUISETACEAE

Equisetum sp.

In his report on the Frontier plants Knowlton described and figured a species of *Equisetum* based on a supposed underground stem. In our collection of the past summer we have a specimen referable to his species, but it is far from being a convincing representative of the genus. Other specimens have been found, however, of a much less doubtful nature. A nodal diaphragm is shown in fig. 18. This was associated with rather poorly preserved stem fragments which, although a specific name would be meaningless, does attest to the presence of the genus in the flora.

PLANTAE INCERTAE SEDIS

Baiera sp. (?)

The problematical specimens described under this name were found at only one locality, about 1½ miles north of Little Muddy Creek. The most complete specimen that was collected is shown in fig. 28. It may be noted that this dichotomizes five times and, as in the other specimens illustrated (figs. 19, 23, 25), the branching is equal or nearly so in all cases.

In the right-hand primary fork of the specimen shown in fig. 28 a single vein may be discerned in each subdivision. The vein divides some distance before reaching the dichotomy of the lamina (this term is employed on the assumption that the fossil does represent a leaf of the *Baiera* type). Unfortunately, the fossils are preserved in a coarse sandy shale, there being no cuticular remains.

There is a close superficial similarity between our specimens and certain species of *Baiera,* particularly *B. spectabilis* (Walton, '40, *fig. 124a)* and a specimen tentatively referred by Seward to *B. Lindleyana* (Seward, '26, *pl. 10, fig. 101).* There are, however, other possibilities that merit consideration.

In 1895 Seward described, under the name of *Becklesia anomala,* a fossil plant from the Wealden of England, consist-

ing of a central axis with pinnately arranged branches which in some cases "appear to bifurcate close to the point of attachment to the central axis." He compared his specimen with the peculiar forked leaflets of the living *Macrozamia heteromera* Moore. A study of herbarium specimens of the latter revealed a rather striking similarity although the Frontier fossils are somewhat larger and appear to have been more laxly disposed.

Summary

The preceding is an account of certain fossil plants from the Upper Cretaceous Frontier formation of Wyoming. Well-preserved compressions of fertile pinnae of a schizaeaceous fern are described and shown to be referable to *Anemia Fremonti* Knowlton. Since the sterile and fertile parts of the frond have not been found in actual organic connection the latter are described as forma *fertilis*.

Fronds of the supposed polypodiaceous fern *Dryopteris coloradensis* Knowlton are shown to possess vegetative characters distinctive of *Gleichenia* and are redescribed as *Gleichenites coloradensis*.

Spores have been obtained from the fertile fronds of *Microtaenia variabilis* Knowlton and *M. paucifolia* (Hall) Knowlton.

The presence of *Equisetum* in the flora is recorded and fossils referable to *Baiera* are described.

Acknowledgment

For the carefully prepared drawings composing plates 6 and 7 we are especially grateful to Mr. Albert A. Heinze.

Literature Cited

Berry, E. W. (1911). A Lower Cretaceous species of Schizaeaceae from eastern North America. Ann. Bot. **25**: 193–198.

Hirmer, M. (1927). Handbuch der Palaobotanik. München.

Knowlton, F. H. (1917). A fossil flora from the Frontier formation of southwestern Wyoming. U. S. Geol. Surv. Prof. Paper 108-F: 73–94.

————, (1919). A catalogue of the Mesozoic and Cenozoic plants of North America. U. S. Geol. Surv. Bull. 696.

Radforth, N. W. (1938). An analysis and comparison of the structural features of *Dactylotheca plumosa* Artis sp. and *Senftenbergia ophiodermatica* Goeppert sp. Trans. Roy. Soc. Edinb. **59**: 385–396.

————————, (1939). Further contributions to our knowledge of the fossil Schizaeaceae; genus *Senftenbergia*. *Ibid.* **59**: 745–761.

Seward, A. C. (1894). The Wealden Flora. Cat. Mes. Pl. Geol. Dept. Brit. Mus. I.

————————, (1895). *Ibid.* II.

————————, (1900). The Jurassic Flora. I. The Yorkshire Coast. *Ibid.* III.

————————, (1926). The Cretaceous plant-bearing rocks of western Greenland. Phil. Trans. Roy. Soc. Lond. **B215**: 57–175.

————————, (1935). Selections from the story of plant migration revealed by fossils. Sci. Prog. **30**: 193–217.

Stopes, M. C., and K. Fujii (1910). Studies on the structure and affinities of Cretaceous plants. Phil. Trans. Roy. Soc. Lond. **B201**: 1–90.

Thomas, H. H. (1911). On the spores of some Jurassic ferns. Proc. Cambridge Phil. Soc. **16**: 384–388.

Veatch, A. C. (1907). Geography and geology of a portion of southwestern Wyoming. U. S. Geol. Surv. Prof. Paper 56: 1–178.

Walton, John (1940). An introduction to the study of fossil plants. London.

Explanation of Plate

PLATE 1

Anemia Fremonti Knowlton forma *fertilis* Andrews.

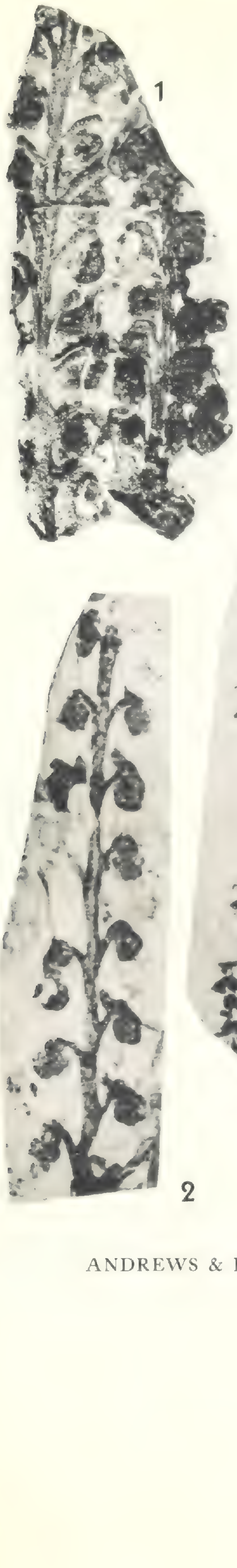
Fig. 1. Two primary branches of fertile pinna. Photograph from a nitrocellulose transfer. No. 1312, × 4.

Fig. 2. Primary branch of fertile pinna. Only one pinnule cluster is shown on each secondary branch, the others having been removed with the counterpart, lost prior to fossilization, or are deeply imbedded in the matrix. No. 1309, × 3.3.

Fig. 3. A nearly complete young fertile pinna. No. 1313, × 3.

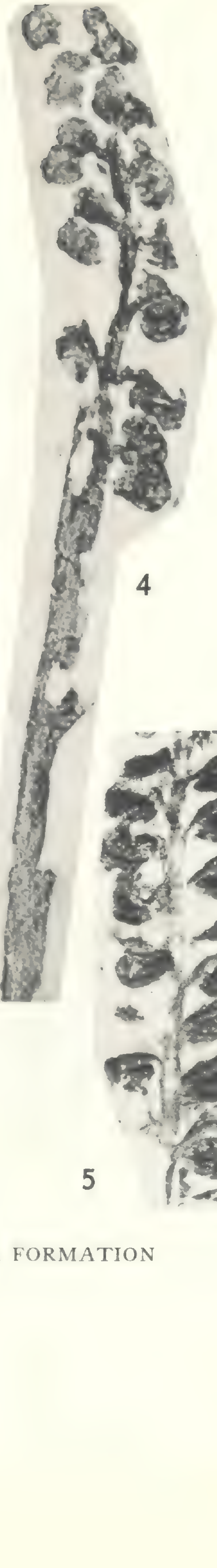
Fig. 4. Primary branch of a somewhat older fertile pinna, as evidenced by its greater size and more expanded condition of the pinnule clusters. Two of the latter may be clearly distinguished on most of the secondary branches. No. 826, × 3.2.

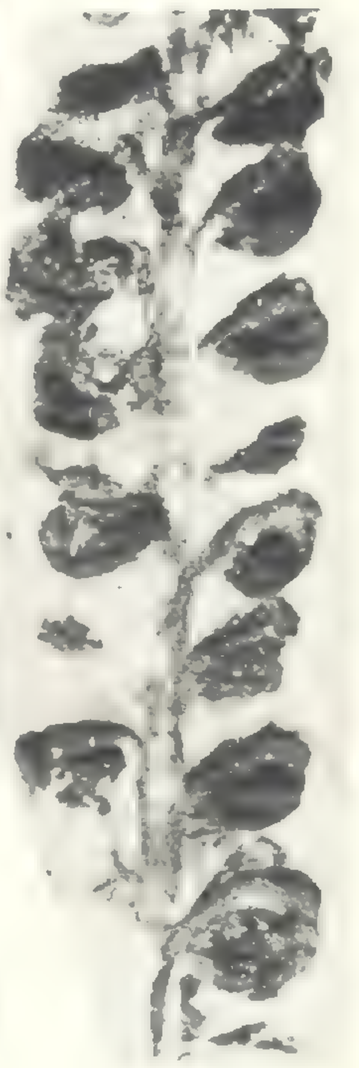
Fig. 5. Primary branch of a fertile pinna. Photograph from a nitrocellulose transfer. No. 1311, × 4.


1

2

3


4


5

ANDREWS & PEARSALL—FLORA OF FRONTIER FORMATION

EXPLANATION OF PLATE

PLATE 2

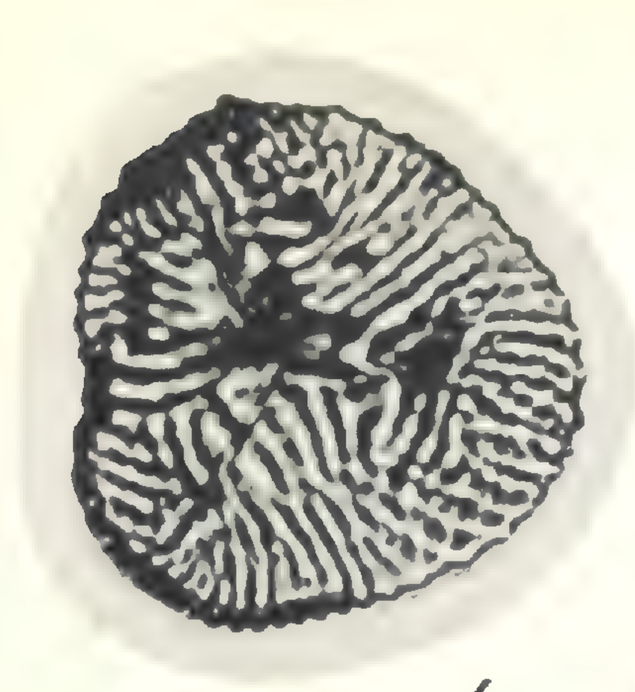
Figs. 6–12. Spores of ***Anemia Fremonti*** forma ***fertilis.*** **Figs. 7 and 8** are of opposite sides of the same spore. Fig. 12 is of a tetrad, all × 750.

Figs. 13–15. ***Microtaenia variabilis*** Knowlton. **Fig. 13.** Portion of fertile frond. No. 1308, × 4.8. Fig. 14. Portion of same more highly magnified, × 24. **Fig. 15.** Spore, × 750.

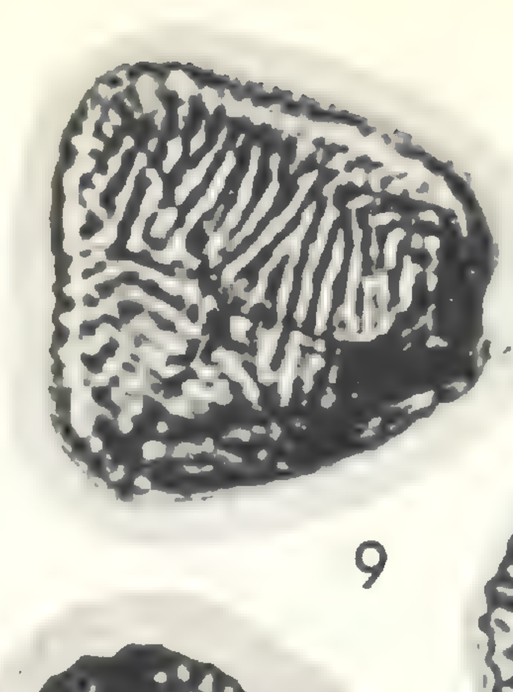
Fig. 16. ***Microtaenia paucifolia*** Knowlton. Portion of fertile frond showing the large, terminal, globose sori (or sporangia?). No. 1310, × 1.7.

Fig. 17. Spore of same, × 750.

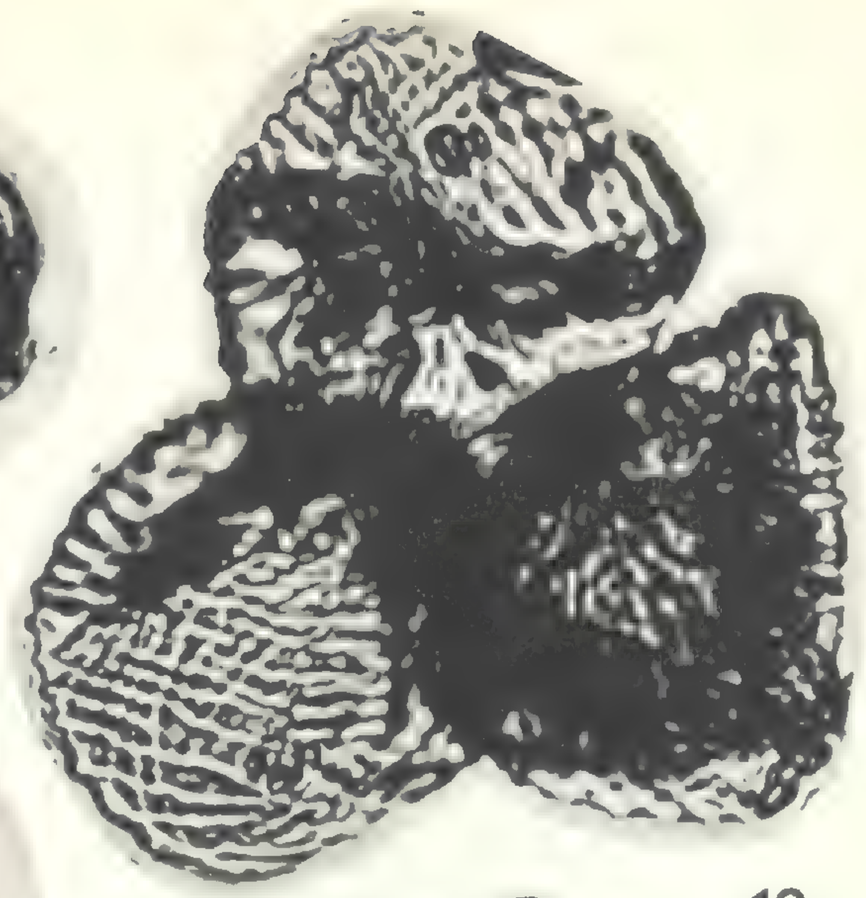
Fig. 18. *Equisetum* sp. nodal diaphragm, × 2.3.



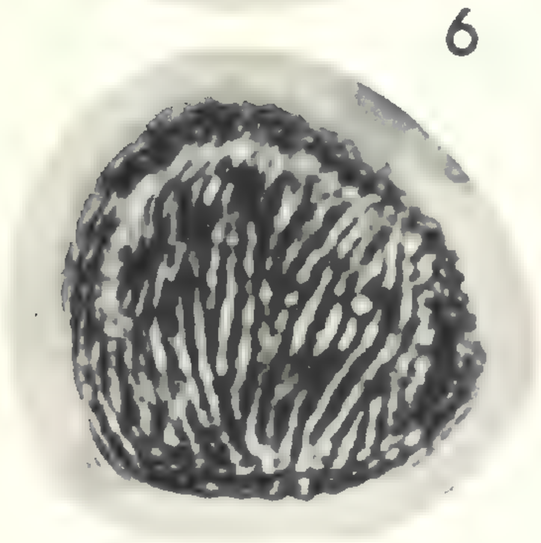
6



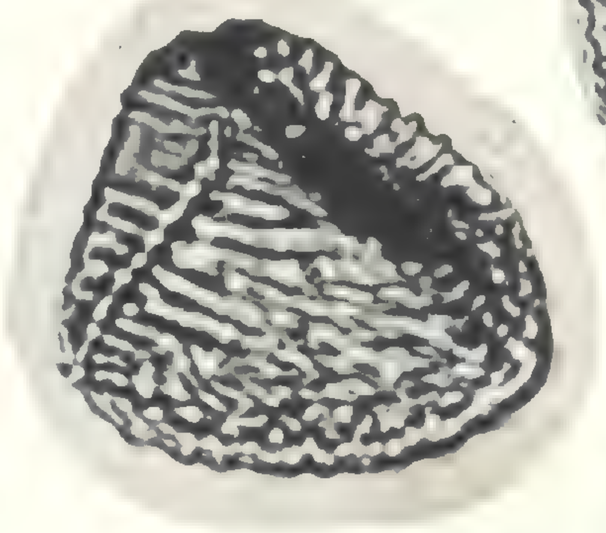
9



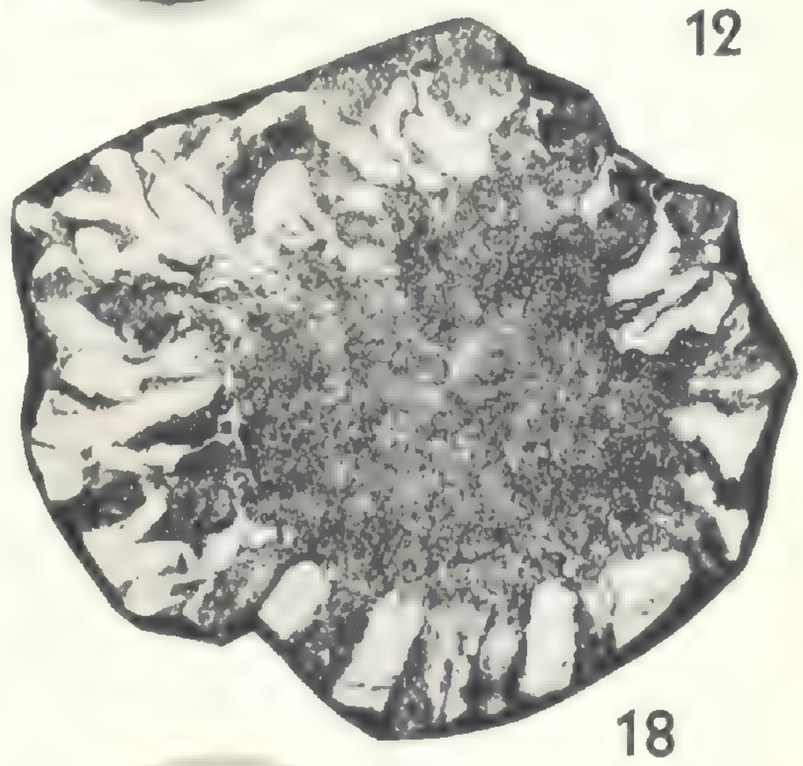
12



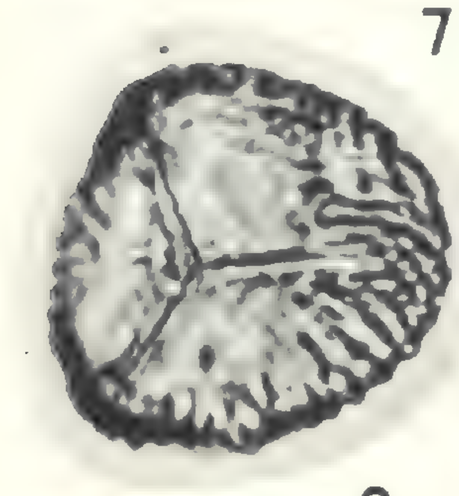
7



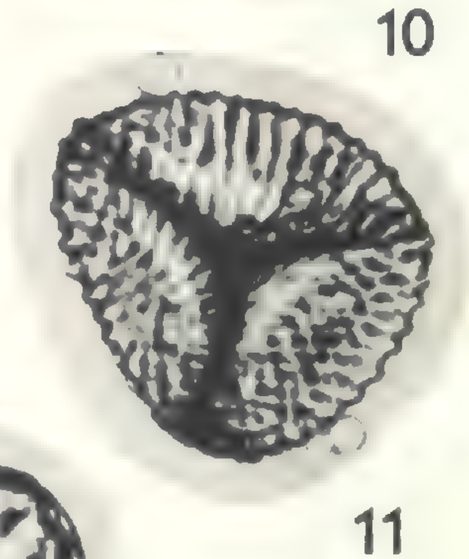
10



18



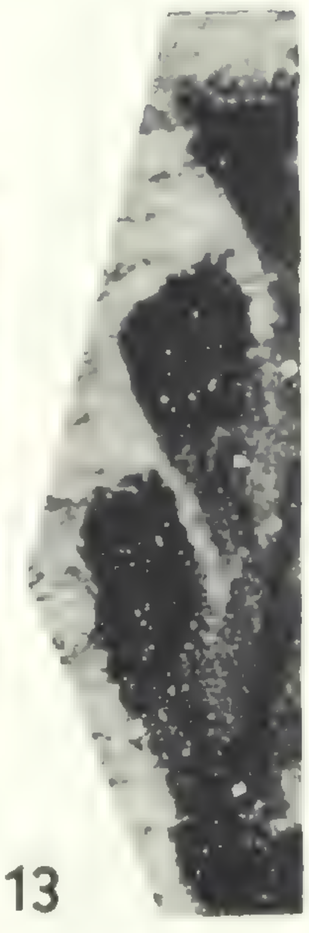
8



11

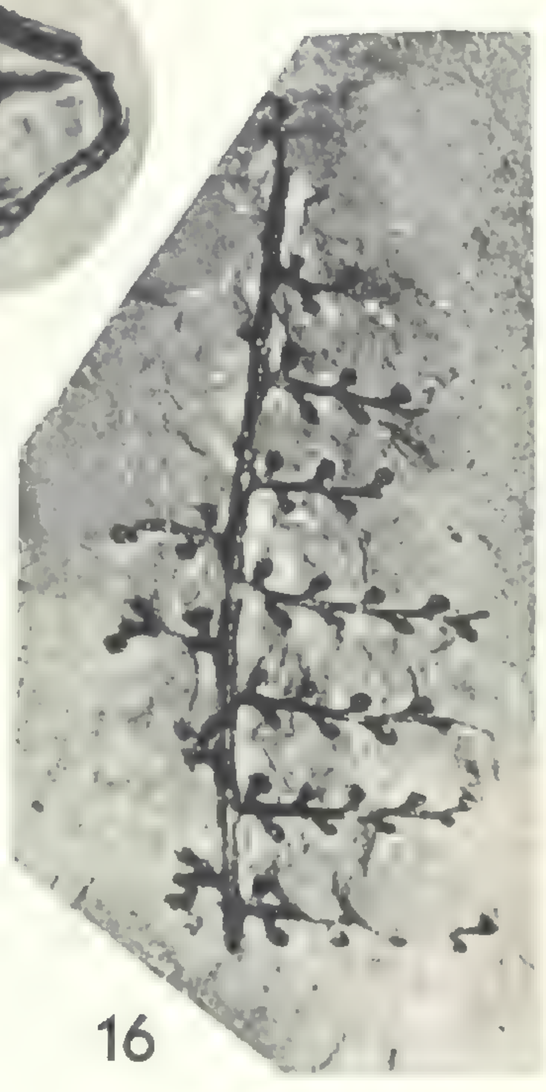
17

15



13

14



16

ANDREWS & PEARSALL—FLORA OF FRONTIER FORMATION

EXPLANATION OF PLATE

PLATE 3

Figs. 19, 23. *Baiera* sp. Fig. 19. No. 1302, × 1.3. Fig. 23. No. 1301, × 1.

Figs. 20, 21, 22, 24. *Gleichenites coloradensis* (Knowlton) Andrews. Fig. 20. Basal portion of frond showing primary branching. No. 1296. Fig. 21. Portion of frond showing secondary and tertiary branch. No. 1293. Fig. 22. Photograph of the counterpart of the specimen shown in fig. 21. The negative was reversed in order to show the two in the same orientation. No. 1294. Fig. 22*a* corresponds to fig. 21*a*, while the fourth order of branching is shown at fig. 22*b*. Fig. 24. Final (fourth) branching showing pinnule morphology. No. 1298. All approx. × .8.

ANDREWS & PEARSALL—FLORA OF FRONTIER FORMATION

EXPLANATION OF PLATE

PLATE 4

Figs. 25, 28. *Baiera* sp. **Fig. 25.** No. 1304, × 1. **Fig. 28.** No. 1303, × 1.4.

Figs. 26, 27, 29. *Gleichenites coloradensis.* **Fig. 26.** Primary branching of frond. No. 1292, × 1. **Fig. 27.** Fourth order of branching. No. 1291, × 1. **Fig. 29.** Portion of a terminal branch showing pinnule morphology. No. 1297, × .9.

ANDREWS & PEARSALL—FLORA OF FRONTIER FORMATION

EXPLANATION OF PLATE

PLATE 5

Figs. 30, 31, 32, 34. *Anemia* sp. Portions of sterile fronds. Explanation in text. Fig. 30. No. 1300, × 1. Fig. 31. No. 1299, × 1. Fig. 32. No. 1307, × 1. Fig. 34. No. 1295, × .9.

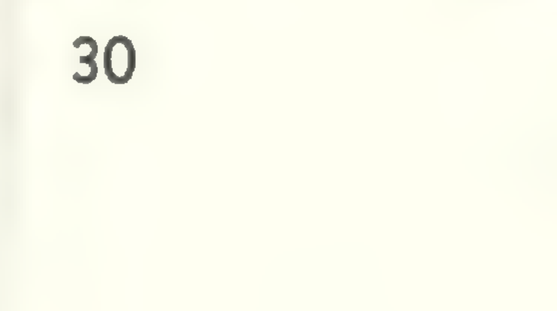
Fig. 33. ***Anemia Fremonti* forma *fertilis.*** Annulus, × 160.

Fig. 35. *Anemia Fremonti.* Terminal portion of frond. No. 1305, × 1.

30

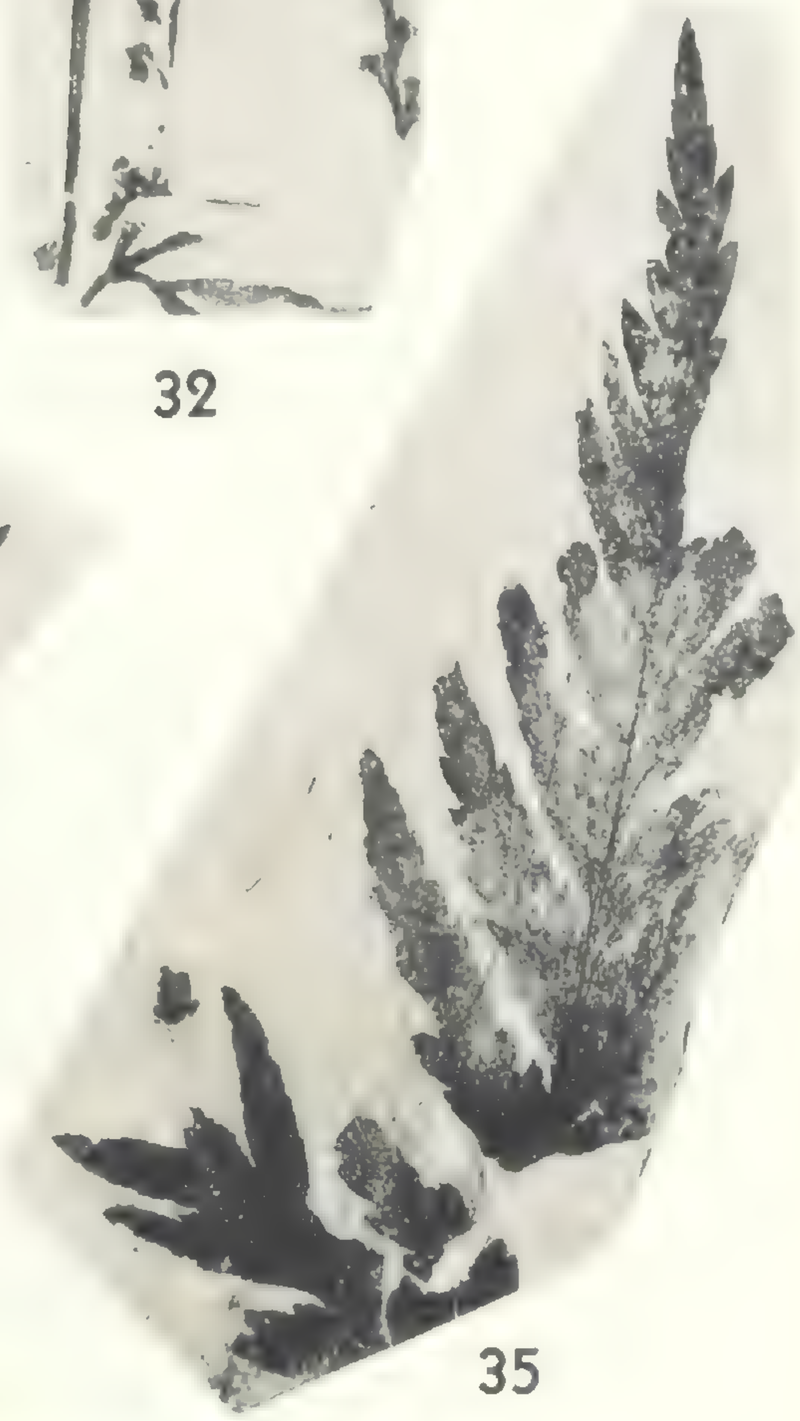
31

32



33

34



35

ANDREWS & PEARSALL—FLORA OF FRONTIER FORMATION

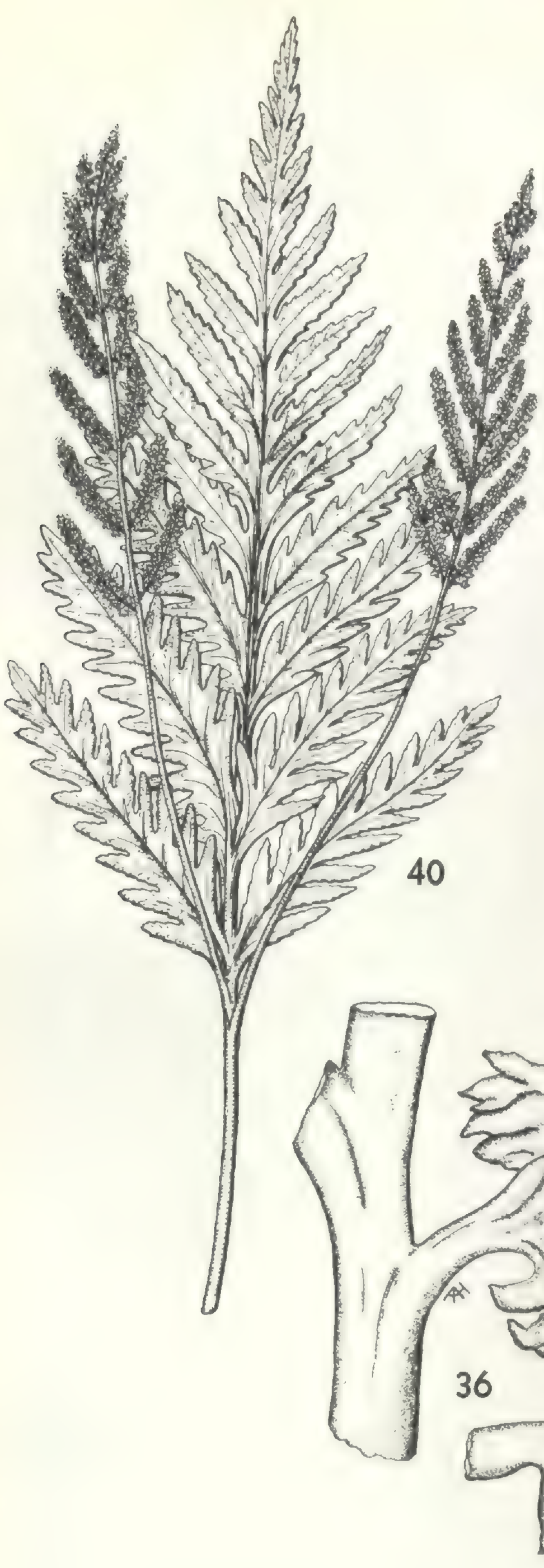
EXPLANATION OF PLATE

PLATE 6

Figs. 36–38. *Anemia Fremonti* forma *fertilis.* Fig. 36. Portion of primary branch of a fertile pinna showing a secondary branch after treatment with macerating fluid, × 15. Fig. 37. A single pinnule cluster in side view showing the sporangia arranged in two rows along the under-surface of the pinnules, × 30. Fig. 38. Under-surface of a single pinnule, × 30.

Fig. 39. *Anemia Fremonti.* Part of sterile portion of frond. No. 1306, × 1.

Fig. 40. Restoration of complete frond.


40

39

36

38

37

ANDREWS & PEARSALL—FLORA OF FRONTIER FORMATION

EXPLANATION OF PLATE

PLATE 7

Fig. 41. Restoration of frond of *Gleichenites coloradensis.*

THE NORTH AMERICAN ASCLEPIADACEAE

I. Perspective of the Genera

ROBERT E. WOODSON, JR.

Assistant Curator of the Herbarium, Missouri Botanical Garden
Assistant Professor in the Henry Shaw School of Botany of Washington University

Introduction

The problem of the North American genera of Asclepiadaceae has been summarized well by Standley (Fl. Costa Rica **3**: 949. 1938): "The family is noteworthy for the complicated structure of the flowers, more complicated, probably, than those of any other family of plants. The Mexican and Central American members of the group have never been monographed properly, and their classification is at present in a decidedly chaotic state."

It is unfortunate that Charles Darwin did not compose a study on the floral structure and pollination of Asclepiads as a companion to his famous observations on Orchids. In both groups, as distantly related as Dicotyledons and Monocotyledons may be, entomophily has produced elaborate and variable innovations from group to group. But apparently with the same intention: for the attraction of insects and cross-fecundation by them, through means of a pollinium.

The Orchids have responded to entomophily largely by zygomorphy and elaboration of the perianth. In the Asclepiads, on the other hand, actinomorphy has been retained, and, although corolline modifications are obvious, diversification is due chiefly to the structural plasticity of the staminal filaments. These elaborations of the stamens are known as the corona. Since the anthers of Asclepiads are invariably five in number, it obtains that the corona also is five-parted, the segments being quite free or mutually coherent, and diversified in ways that are too numerous for description. Although a staminal corona is the rule for the group, a few entities possess

Issued April 28, 1941.

simple filaments. In any event, the center of the flower is occupied by a composite structure known as the gynostegium, comparable to the column of Orchids. This consists of the five coherent stamens surrounding the style of the bicarpellate pistil, with an enlarged terminal "stigma head" at the free end. The whole stigma head is not truly stigmatic, the receptive surfaces being five narrow strips of glandular tissue between the contiguous anthers.

The anthers of American Asclepiads are bilocular, and within each cavity the pollen grains are grouped at maturity into a glutinous, sac-shaped pollinium of definite form and size. In the subfamily Cynanchoideae, containing all the New World species, these pollinia are combined by pairs through a more or less elaborate yoke mechanism called the translator. The translators consist of two arms* attached to their respective pollinia, and are themselves joined by a roughly sagittate body called the "gland."* A pair of pollinia, therefore, consists of the contents of adjacent anther cavities of contiguous anthers. The translators, with their glands, are formed between the neighboring anthers.

The current explanation of the formation of the translators is that their substance consists of the solidified secretion of special glandular cells located upon the stigma head. Investigations of my own, not yet completed, lead me to assume that in the early development of the pollinia the tapetal liquid, characteristically abundant in young anthers, seeps through small pores of the neighboring anthers to gather in the commissural grooves of the two organs. This liquid later solidifies outside the anther as well as about the pollen, instead of being absorbed as is usually the case. Superficial support is given this view by the fact that the uniting "gland" always is distinctly 2-parted. According to either view, the translators are moulded when still in the liquid state by the available spaces between the young anthers.

*"Translator arm" and "gland" frequently are called "retinaculum" and "corpusculum" respectively in the literature. The former are chosen here as being somewhat more easily associated with the appearance of the structures as well as more adaptable to English: the latter are more useful in Latin diagnoses.

When the pairs of pollinia are mature they are easily removed from the dehiscent anthers by means of the yoke-like translators. A visiting insect may be observed to pull them out and carry them away suspended from its legs. On the same or another flower, the pollinium must be inserted between the anthers at the stigmatic surface, in order to insure pollination. At that time, in response to the stigmatic secretions, pollen tubes germinate from the pollinium while still intact, to travel down the style to the ovules. The significance of the pollinia and their method of fecundation were fully appreciated for the first time by Robert Brown (Mem. Wern. Soc. **1**: 12–58. 1809) in his celebrated paper distinguishing the Asclepiads from the Apocynads.

The method of pollination in Asclepiads which Robert Brown disclosed appears at first sight to be of design so cunning that great fecundity of the plants should be assured, as well as frequent hybridization. Every conceivable innovation would seem to have been made by the flowers to insure successful insect ministrations. But such does not necessarily seem to have resulted. The family as a whole is outstanding for the constancy of its species and the rarity of obvious hybridity. Furthermore, the amount of fruit produced scarcely seems to be commensurate with the "efforts" taken to insure it, to speak anthropocentrically.

Accounts of the pollination of Asclepiads seldom mention the actual difficulties intervening: the danger of the pollinia being broken or only partially withdrawn by the insect's casual visits; the horny margins of the anthers which seclude the stigma, frequently with entangling hooked or grooved decorations.

Germinated pollinia are conspicuous, even in dried and boiled material, because of the abundant, felty pollen tubes. Amongst the hundreds of flowers of various genera and species which I have dissected under magnification, I have found very few indeed bearing germinated pollinia in the stigmatic chamber between the anthers. Of those few, the companion pollinium was usually in place in its mother anther sac. In nu-

merous instances I have found germinated pollinia while still within the anther sac. Whether such pollen tubes can reach the ovules successfully has not been ascertained, but it is not impossible. Such observations explain to some extent the rarity of hybridization, but fail to shed much light on the use of the pollinia as agents for pollination by insects.

Another feature of the Asclepiad flower which would appear to have little positive survival value is the division of the stigma into five rather restricted receptive regions. This apparently is responsible for the fact that only one follicle commonly develops from the two carpels of the pollinated pistil. Thus, even though three stigmatic surfaces were to receive pollinia, fecundation of only one carpel might result: but it must be confessed that conversely were only two pollinia deposited development of both follicles might ensue. A pair of follicles, nevertheless, is seldom encountered. Perhaps it is safe to assume that the reduction in number of fruits is compensated by the volatility of the comose seeds.

The classification of Asclepiadaceae into major divisions is based upon the nature and position of the pollinia, and thus owes its foundations to the classical observations of Robert Brown (Mem. Wern. Soc. **1**: 12–58. 1809). That versatile genius separated the family as it is now recognized into five tribes: Periploceae, with open cornucopia-shaped pollinia and adhesive translators somewhat as in the Orchids; Secamoneae, with 4-locular anthers, the yoke-like translators bearing two pollinia upon each arm; Asclepiadeae Verae, with 2-locular anthers, the yoke-like translators bearing a single pendulous pollinium upon each arm; Gonolobeae, with pollinia similar to those of Asclepiadeae Verae, but horizontal; and Stapelieae, with similar, but erect pollinia. Recent systems (cf. K. Schumann, in Engl. & Prantl, Nat. Pflanzenfam. **4**^{2}: 209. 1895) have divided the family into two subfamilies, Periplocoideae and Cynanchoideae; the latter having four tribes, Asclepiadeae, Secamoneae, Tylophoreae (Stapelieae of Brown), and Gonolobeae. In the New World only the Cynanchoideae are encountered in the native flora, with the three tribes Asclepiadeae, Gonolobeae, and Tylophoreae.

In these studies no attempt will be made to subdivide the tribes into the smaller subdivisions advocated by Schumann, for these are manifestly unnatural. Thus the genus *Sarcostemma* R.Br. (sensu stricto) was placed in the subtribe Cynanchinae of Asclepiadeae by that author (K. Sch. in Engl. & Prantl, Nat. Pflanzenfam. 4^2: 245. 1895), but the two certainly synonymous genera, *Philibertia* HBK. and *Funastrum* Fourn., in the Glossonematinae and the Asclepiadinae respectively (pp. 225, 231. loc. cit.). I am inclined also to ignore Schumann's subtribe Astephaninae, characterized by the absence of a corona, since in all cases which I have observed the absence of a crown is the only character separating species groups of obviously close affinity, notably in the inclusive treatment of *Cynanchum* adopted here. One monotypic genus, *Tylodontia* Griseb. (treated as a division of *Cynanchum* here), Schumann includes in the Astephaninae, but I have observed the presence of definite corona segments in an isotype deposited in the herbarium of the Missouri Botanical Garden *(Wright 2964)*. Neither can Oxypetalinae of Schumann be maintained by the appendages of the translator arms, since several South American species of the single genus, *Oxypetalum*, do not have those structures.

The separation of the American Asclepiads into tribes sometimes is a bit difficult, since the position of the pollinia usually must be observed while they are still within the anther sac. Once withdrawn and placed upon the dissecting stage, the delicate translator arms are apt to twist into any conceivable attitude, frequently giving a false impression of their natural position. The Asclepiadeae and Tylophoreae usually are quite easy to detect; but the Gonolobeae have given trouble from the start. I am willing to be convinced that the normal position of the Gonoloboid pollinium may be truly horizontal, although my interpretation of the tribe includes forms with pollinia that range in position from pendulous to ascending. By far the best means that I have found to separate this tribe is by means of the structure, not the position, of the pollinia.

In all the Asclepiadeae and Tylophoreae examined by me, the faces of the pollinium are uniformly rounded or flattened on

either side, and the translator arm makes a sharply definite connection with them. In the Gonolobeae, on the other hand, the faces of the pollinium are more or less dissimilar: one convex or rounded and the other flattened or somewhat excavated, frequently very strikingly so. In some cases both sides are deeply furrowed or excavated. In the Gonolobeae, also, the translator arm usually engages the pollinium more gradually, the attachment being marked by a more or less conspicuous hyaline indentation or margin (always the upper). Without the use of this structural criterion, Schumann placed such genera as *Macroscepis* and *Fischeria* in the Asclepiadeae and *Metalepis* in the Gonolobeae, whereas other characters of the plants show their natural positions to be exactly the reverse, as shall be explained presently.

At this writing ninety-seven genera of Asclepiadaceae have been described from North America, based wholly or in large part upon the structure of the corona. Authors of the great majority of these genera seem not to have understood what a versatile feature this organ is, for it is only when its multifarious aspects are interpreted in a broad and comparative manner that a natural and conveniently referable classification can result. North American students of tropical Asclepiads, particularly, would do well to consider the floral variability of the native Milkweeds before attempting the description of exotic genera. The prospective Asclepiadologist should understand from the first that differences of the corona separate species in this family, which would form remarkable generic criteria, say of the "disc" in other families. After the first shock of surprise at the few genera recognized for North America, readers of the following key to genera may notice the fairly incidental use of corona characters. These are reserved chiefly for subgeneric and sectional distinctions, and will be discussed in that connection.

The term "corona" has been taken in a rather restricted sense in these studies. Amongst earlier literature frequent mention is made of "double" or even of "triple" coronas. This terminology is very confusing except to the authors concerned. Morphologically, the corona, as interpreted here,

consists of various elaborations or enations of the staminal filaments only. These enations may occur as separate bodies attached to the staminal column, as in *Asclepias,* to cite a familiar example, or may consist of a more or less entire ring of tissue adnate to the bases of both staminal column and corolla throat. Where "double" or "triple" coronas have been described by various authors, these usually will be found to consist of a faucal annulus of the corolla tube, or sterile appendages of the anthers, which are rather to be called such than to be referred to as corona.

The most cogent reason for avoiding the use of "corona," except in a simple sense, is that many readers of the literature are apt to interpret a corona as double, whilst the author may not intend such a view. Several instances of possible or published confusion arising from an author's use of "double corona" come to mind. In the subgenus *Chthamalia* of *Matelea,* for example, the corona consists of an annular structure of five more or less united and variously constituted segments, each of which bears internally a more or less conspicuous ligular process, sometimes surpassing the height of the subtending segment. Contrary to what one might suppose, this complex structure is not considered by the literature as a "double corona." The flowers of *Gonolobus* (sensu stricto) are very difficult to identify with standard keys, for they usually possess (1) a faucal annulus of the corolla, (2) a fleshy, true corona, (3) dorsally appendaged anthers. Some authors interpret these structures as constituting a "triple" and some as a "double" corona. Those maintaining the dual nature may construe either the corolline annulus or the anther appendages as the supernumerary corona, in which cases the true corona will be spoken of as either the "inner" or the "outer" corona, respectively.

The segregate genus *Podostigma,* of the southeastern United States, is keyed by K. Schumann (in Engl. & Prantl, Nat. Pflanzenfam. **4**^{2}: 235. 1895) on the basis of having an "inner corona" borne high upon the column, alternate with the anthers. When these tiny objects are examined, however, they are found to be nothing but the minute ligules commonly alter-

nating with the corona hoods in *Asclepias* proper, their normal position doubtless having been disturbed by the elongation of the anther stipe* above the insertion of the hoods. In *Fischeria,* also a "double corona" is described in all texts. But when carefully dissected, the bladder-like "inner corona segments" are found to be nothing but the hypertrophied anthers themselves. This peculiar mark of *Fischeria* may be described more accurately and more clearly upon the basis of anther structure than by introducing an ambiguous and morphologically indefensible reference to supposed "corona."

The North American Asclepiadaceae have never had the attentions of a specialist devoted primarily to their study, except for the period between 1897 and 1904 during which a series of eight short papers by Miss Anna Murray Vail appeared in the 'Bulletin of the Torrey Botanical Club.' These papers consist only of short notes, with the exception of rather casual revisions of *Acerates,* the *Asclepias verticillata* complex, and *Rouliniella* (i.e. *Cynanchum* subgenus *Mellichampia,* in part, of my studies). Even from these small and interrupted beginnings, it is obvious that Miss Vail possessed a very considerable knowledge and insight into the North American Asclepiads, and it is regrettable that her retirement to France terminated her ambitions for more comprehensive works. I must confess that more than once, when I was apparently undergoing swift mental attrition because of the damnably variable coronas and pollinia, I have reflected on my predecessor's retreat to the Riviera.

The South American and Antillean Asclepiads have had several specialists, including Decaisne, Fournier, Schlechter, and Malme; to these must be added the contemporary South American botanists, A. G. Schulz and F. C. Hoehne. The work of these eminent systematists, however, has nearly always been in the field of regional floristics, with few exceptions, such as Malme's monograph and subsequent emendations on *Oxy-*

* I have found it convenient in dealing with some genera to distinguish two regions of the staminal column: that below the attachment of the corona as the "column," as in most species of *Asclepias* proper, and that above, between the corona and the anthers proper, as the "stipe," as in *Podostigma.*

petalum. But these contributions have affected the northern Asclepiads only in rather minor particulars. Regional floras of North America have included thoughtful interpretations of the Asclepiadaceae in several instances, but have been hindered by their restricted scope and the divided interest of their authors.

Special mention should be made here to the monograph of *Marsdenia* by Rothe (in Engl. Bot. Jahrb. **52**: 354–434. 1915), not only since it is the only comprehensive account of an Asclepiad genus in both American continents, but because the author's solution of the problems of this group closely parallel my own for the family. Confronted by an aggregation of eight segregate genera, nearly all in current use but with very evasive criteria when seen as a whole, Rothe courageously combined them as sections. The result, in spite of some imperfections, is the one bright spot in the determination of tropical American Asclepiads from the existing literature. In the Tylophoreae, at least, one needs no longer to puzzle over the generic interpretation of floral innovations, nor fear that the specimen he is trying to determine may already be described as a new genus in some remote section of the taxonomic indices. At the same time, a natural system of species groups is defined and provided with names which may (or should) be used in the description of novelties, or to which additions may even be made should sufficiently discrepitant plants be found.

A lifetime would be too short to perfect a complete system of the North American Asclepiads. But after an intensive study of several years, I have arrived at a definition of the genera which I believe may well lead to a more adequate understanding of the complex as a whole. The result is a revolutionary change in nomenclature which surely will not be regretted more by the reader than by the author. The change clearly is unavoidable because of the long neglect of the family.

In this group of plants apparent entomophily has produced a floral structure even more complicated and variable than in the Orchids. Morphological details separate species and even varieties here, which would serve to distinguish genera in other groups of Flowering Plants. The student of the Asclepiads is

impelled to the defeatist attitude that only two choices are available in classification: to "lump" genera or to "split" them. If he continues the study of Milkweeds sufficiently long, he probably will find himself tossed from horn to horn of the dilemma.

After several such harrowing experiences, I have recognized that a narrow concept of coronal structure as a criterion of genera, if pursued consistently, will lead to a multitude of monotypic entities—as a matter of fact, that few genera will consist of more than two or three species—and that each new species will introduce anew the question of generic differentiation. This is scarcely an exaggeration when one remembers that an inclusive concept of North American *Asclepias*, alone, involves the listing of twenty generic synonyms. If he contemplates an extended association with the Asclepiadaceae, with yearly increments of specimens brought to his attention for classifying, even the most hardened "liberal" taxonomist will take heed before embarking upon such a disastrous course.

Although the results of my studies wreak havoc upon the existing classification, I feel confident that the groups proposed are natural, and that they will stand the test of many years. The desideratum of stability and convenience will be served much better in having a few, almost infallibly recognizable genera even though they may be large: the natural affinities within these groups may be indicated sufficiently by the erection of subgenera and sections.

This paper is intended as the forerunner of a series devoted to the North American Asclepiadaceae. It is composed as a general survey of the generic elements involved, together with an indication of representative changes in nomenclature made necessary by my visualization of the natural system of the family. These species are drawn only from those with which I am familiar at this time, and should not be considered as complete synopses; neither do they include species not requiring adjustment in terminology. The synonymy, also, is not complete, consisting merely of the name-bringing and other more prominent synonyms. To some readers, the inclusion of the many nomenclatural changes upon such a scanty prepara-

tion may seem precipitate. The decision to include them here, rather than to withhold them for subsequent, complete revisions, has been made in view of the advantages of concrete illustration of the generic elements proposed, the uncertainty of our ability to obtain European types necessary for a complete study within the near future, and the validation of obviously necessary names for the purpose of present determinative work. Should the future permit, this paper will be followed by a monograph of the North American species of *Asclepias*, and by subsequent revisions of the other important genera, in each case with all recognized species illustrated by analytical drawings.

To be of wide use, a critical study of the Asclepiadaceae should be illustrated profusely. I feel that an apology is in order, therefore, because of the total lack of analytical drawings in this paper. Their absence is due in part to the conditions of publication at the moment, and in part to plans which I have made for their inclusion in future studies. After all, this paper is scarcely more than an annotated key to genera, and of little interest save to specialists. Such readers will be sufficiently familiar with the structures to which I call attention not to miss the figures.

Key to the Tribes and Genera

Pollinia strictly pendulous, their faces uniformly flattened or rounded, uniformly fertile to the attachment of the translators..... ASCLEPIADEAE

Pollinia usually horizontal or essentially so, occasionally ascending or descending, but one or both faces more or less excavated, and with a sterile hyaline margin or indentation near the attachment of the translators....GONOLOBEAE

Pollinia strictly erect, their faces uniformly rounded, uniformly fertile to the attachment of the translators..... TYLOPHOREAE

ASCLEPIADEAE

Erect or decumbent perennial herbs; pollinia very strongly flattened; corona of 5 cucullate, calceolate, or clavate hoods, usually with an internal horn or crest.....I. ASCLEPIAS

Lianas or twining undershrubs; pollinia faces broadly rounded or only slightly compressed.

Arms of translators conspicuously thickened and appendaged near their attachment to the gland.....II. OXYPETALUM

Arms of translators not as above.
Corona of 5 separate or united, laminate to filiform scales, occasionally compounded or with internal processes, rarely wholly lacking.....III. CYNANCHUM
Corona of 5 semi-vesicular sacs attached separately to the backs of the anthers.....IV. BLEPHARODON
Corona of 5 closed inflated vesicles joined at the bases by a fleshy ring adnate to the corolla-throat.....V. SARCOSTEMMA

GONOLOBEAE

Anthers relatively simple, not conspicuously vesicular, nor with dorsal appendages; corolla lobes various, but not crisped.....VI. MATELEA
Anthers very conspicuously hypertrophied and vesicular throughout; corolla lobes strikingly crisped.....VII. FISCHERIA
Anthers with spreading, more or less laminate, fleshy dorsal appendages; corolla lobes various, but not crisped.....VIII. GONOLOBUS

TYLOPHOREAE

One genus.....IX. MARSDENIA

I have been unable to interpret two enigmatic genera of Baillon, *Microstelma* (Hist. Pl. **10**: 286. 1891) and *Stelmagonum* (loc. cit. 287), both placed in the Gonolobeae and thus probably synonymous under *Matelea*.

I. ASCLEPIAS L. Sp. Pl. 214. 1753.

Anthanotis Raf. Fl. Ludov. 52, 149. 1817.
Anantherix Nutt. Gen. N. Am. Pl. **1**: 169. 1818.
Stylandra Nutt. loc. cit. 170. 1818.
Otaria HBK. Nov. Gen. **3**: 192. 1819.
Acerates Ell. Sketch Bot. S. Carol. **1**: 316. 1821.
Podostigma Ell. loc. cit. 326. 1821.
Acerotis Raf. New Fl. N. Am. **1**: 49. 1836.
Oligoron Raf. loc. cit. 4: 60. 1836.
Otanema Raf. loc. cit. 61. 1836.
Onistis Raf. loc. cit. 63. 1836.
Polyotus Nutt. Trans. Amer. Phil. Soc. n.s. **5**: 199. 1837.
Asclepiodora A.Gray, Proc. Amer. Acad. **12**: 66. 1877.

Schizonotus A.Gray, loc. cit. 1877, non Lindl.
Solanoa Greene, Pittonia **2**: 67. 1890.
Solanoana O.Ktze. Rev. Gen. **2**: 421. 1891.
Oxypteryx Greene, Pittonia **3**: 234. 1897.
Podostemma Greene, loc. cit. 235. 1897.
Biventraria Small, Man. Fl. 1072. 1933.
Asclepiodella Small, loc. cit. 1073. 1933.
Gomphocarpus of American authors.

Key to the Subgenera

A. Corolla rotate to rotate-subcampanulate, the lobes reflexed to somewhat ascending; corona attached to the column immediately beneath the anther head.
  B. Hoods cucullate or cucullate-spatulate to calceolate, rarely strongly conduplicate, erect to spreading, the alternate lobules more or less deeply 2-cleft, rarely absent.
    C. Corolla throat without internal callous processes.
      D. Hoods usually more or less substipitate as seen from within, the basal attachment shallow, conduplicate but not deeply saccate .....1. EUASCLEPIAS
    DD. Hoods very sessile, the basal attachment deeply saccate.
      E. Hoods entire to somewhat cleft ventrally, open but occasionally appressed against the column.
        F. Base of hoods not appendiculate, or merely somewhat keeled laterally.
          G. Hoods with a more or less conspicuous internal horn or crest.
            H. Horn or crest compressed radially; column not deeply saccate between the hoods.....2. ASCLEPIODELLA
            HH. Horn or crest compressed tangentially; column deeply saccate between the hoods.....3. PENTASTOMATIA
          GG. Hoods without a horn or crest.
            H. Hoods with very pronounced marginal lobes, the orifice not appressed against the column..4. ASCLEPIOPHANES
            HH. Hoods with very inconspicuous marginal lobes, if any, the orifice appressed against the column.....5. ACERATES
        FF. Base of hoods with conspicuous, external, laterally excurrent membranous appendages.....6. POLYOTUS
      EE. Hoods almost completely bifid ventrally, closed, completely enclosing the horn if present.....7. SOLANOA
    CC. Corolla with an interrupted faucal annulus of 5 conspicuous callous processes alternating with the hoods; hoods strongly conduplicate, with a conspicuous radially compressed crest....8. ASCLEPIODOLUS
BB. Hoods thickly involute-clavate.
  C. Corolla lobes reflexed; hoods with deeply bifid alternating lobules; translator arms very long.....9. ANANTHERIX

CC. Corolla lobes ascending; hoods with entire alternating lobules; translator arms of moderate length.....10. ASCLEPIODORA
AA. Corolla rotate-subtubular, the lobes erect or only slightly spreading; anther head borne on a slender stipe high above the corona.....
.....11. PODOSTIGMA

This key will not be of great use to those who are not thoroughly familiar with the varying structure of the Milkweed flower. The monograph of the genus which I am preparing will contain the discussion and illustrations of the criteria necessary for general use.

To many readers familiar with the segregate genera of *Asclepias* in a restricted region of the United States, the reduction of such well-established entities as *Acerates, Asclepiodora,* and *Podostigma* may appear as an admission of casual superficiality. Let them study the scores of species of *Asclepias* represented in North America, intensively, for several years, however (and above all, let them attempt to compose an adequate key even to subgenera and sections), and I am convinced that those without prejudice will appreciate the practical and theoretical advantages of "lumping." Fortunately, very few new combinations are necessary by interpreting the genus in a broad sense, for practically all species have been described under *Asclepias* at one time or another. The relatively few exceptions amongst the species with which I am familiar at present are treated under their respective subgenera as follows:

SUBGENUS 1. EUASCLEPIAS

ASCLEPIAS **hypoleuca** (A.Gray) Woodson, comb. nov.
Gomphocarpus hypoleucus A.Gray, Proc. Amer. Acad. **17**: 222. 1881–82.

ASCLEPIAS **Phenax** Woodson, nom. nov.
Acerates humilis Benth. Pl. Hartw. 291. 1848, non *Asclepias humilis* Schltr.

ASCLEPIAS **Pringlei** (Greenm.) Woodson, comb. nov.
Acerates Pringlei Greenm. Proc. Amer. Acad. **34**: 570. 1899.

SUBGENUS 5. ACERATES

ASCLEPIAS **hirtella** (Pennell) Woodson, comb. nov.
Acerates hirtella Pennell, Bull. Torrey Club **46**: 184. 1919.

SUBGENUS 6. POLYOTUS

ASCLEPIAS **Engelmanniana** Woodson, nom. nov.
Acerates auriculata Engelm. in Torr. Rept. Bot. Mex. Bound. Surv. 160. 1859.
Asclepias auriculata (Engelm.) Holzinger, Bot. Gaz. **17**: 125, 160. 1892, non HBK.

SUBGENUS 7. SOLANOA

ASCLEPIAS **Solanoana** Woodson, nom. nov.
Gomphocarpus purpurascens A.Gray, Proc. Amer. Acad. **10**: 76. 1874, non A.Rich.
Schizonotus purpurascens A.Gray, loc. cit. **12**: 66. 1877.
Solanoa purpurascens (A.Gray) Greene, Pittonia **2**: 67. 1890.
Solanoana purpurascens (A.Gray) O.Ktze. Rev. Gen. **2**: 421. 1891.

SUBGENUS 8. ASCLEPIODOLUS

ASCLEPIAS **insignis** (Brandg.) Woodson, comb. nov.
Asclepiodora insignis Brandg. Zoe **5**: 253. 1908.

SUBGENUS 10. ASCLEPIODORA

ASCLEPIAS **circinalis** (Dcne.) Woodson, comb. nov.
Acerates circinalis Dcne. Ann. Sci. Nat. Bot. ii. **9**: 322. *pl. 10, fig. c.* 1838.
Asclepiodora circinalis (Dcne.) Fourn. loc. cit. vi. **14**: 369. 1882.

ASCLEPIAS **Fournieri** Woodson, nom. nov.
Acerates gomphocarpoides Dcne. Ann. Sci. Nat. Bot. ii **9**: 323. 1838, non *Asclepias gomphocarpoides* Schltr.
Asclepiodora gomphocarpoides (Dcne.) Fourn. loc. cit. vi. **14**: 369. 1882.

ASCLEPIAS **zanthodacryon** (Smith & Harris) Woodson, comb. nov.
Asclepiodora zanthodacryon Smith & Harris, Contr. Gray Herb. 114: 12. 1936.

II. OXYPETALUM R.Br. Mem. Wern. Soc. 1: 41. 1809.

Apparently *O. cordifolia* (Vent.) Schltr. is the only representative of this troublesome genus in Central America and the Antilles. Fortunately, this species has strongly appendaged translator arms which enable it to be separated easily from *Cynanchum*. But in South America there are many species without this diagnostic structure, the importance of which will present one of the major problems of the Asclepiads in the southern continent.

III. CYNANCHUM L. Sp. Pl. 212. 1753.

Ditassa R.Br. Mem. Wern. Soc. **1**: 49. 1809.
Metastelma R.Br. loc. cit. 52. 1809.
Enslenia Nutt. Gen. N. Am. Pl. **1**: 164. 1818, non Raf.
Ampelamus Raf. Amer. Monthly Mag. **4**: 192. 1819.
Lyonia Ell. Sketch Bot. S. Carol. **1**: 316. 1821, non Nutt.
Seutera Reichenb. Consp. 131. 1828.
Enslinia Reichenb. loc. cit. 1828.
Roulinia Dcne. in DC. Prodr. **8**: 516. 1844, non A. Brongn.
Orthosia Dcne. loc. cit. 526. 1844.
Tassadia Dcne. loc. cit. 579. 1844.
Irmischia Schlecht. Linnaea **19**: 738. 1847.
Nanaturis Turcz. Bull. Soc. Nat. Mosc. **21**[1]: 254. 1848.
Amphistelma Griseb. Fl. B.W.I. 417. 1861.
Tylodontia Griseb. Cat. Pl. Cub. 175. 1866.
Metalepis Griseb. loc. cit. 179. 1866.
Mellichampia A.Gray, Proc. Amer. Acad. **22**: 437. 1887.
Pattalias S.Wats. loc. cit. **24**: 60. 1889.
Tainionema Schltr. in Urb. Symb. Ant. **1**: 263. 1899.
Decastelma Schltr. loc. cit. 264. 1899.
Rouliniella Vail, Bull. Torrey Club **29**: 662. 1902.
Basistelma Bartlett, Proc. Amer. Acad. **44**: 631. 1909.
Epicion Small, Man. Fl. 1075. 1933.
Astephanus of American authors.

Besides the preceding, several synonyms eventually will have to be added from the South American flora. Very few of

these synonymous genera are absolutely co-extensive, since they are based for the greater part upon variations of the corona. Because these differences are multitudinous but of the same general *motif*, the practical solution of the problem appears to lie in an inclusive treatment, such as that adopted for *Asclepias*. The principal characters used to separate the segregates just enumerated are aestivation of the corolla lobes (whether contorted or valvate—extremely difficult to observe in most species), corona (whether simple or compound, deeply or less deeply divided, or absent), and structure of the inflorescence (whether racemiform or umbelliform—since the basic structure is cymose for all, this distinction resolves itself into a comparison of internode length). These characters combine kaleidoscopically in so many manners, and frequently result in the separation into different genera of so many species of obvious affinity, that they appear of very doubtful value. I am inclined to discount particularly the value of corolla aestivation and corona structure, and to group the North American species under the following subgenera. These I am illustrating with representative adjustments in nomenclature.

Key to the Subgenera

A. Cymes racemiform to corymbiform, with definitely manifest internodes.
  B. Corolla campanulate to rotate-subcampanulate, the throat not constricted at the orifice.
    C. Corona lobes relatively elongate, free or united only at the bases.
      D. Corona lobes acuminate, entire or with very obscure lateral lobules .....1. MELLICHAMPIA
    DD. Corona lobes deeply bifid.....2. AMPELAMUS
    CC. Corona cyathiform, broadly and shallowly lobed, the lobes broadly emarginate .....3. METALEPIS
  BB. Corolla urceolate, the throat constricted at the orifice....4. TYLODONTIA
AA. Cymes umbelliform, usually without the appearance of definite internodes.
  B. Corolla lobes ascending or spreading.....5. METASTELMA
  BB. Corolla lobes inflexed-cucullate.....6. CLEISTOLOBUS

SUBGENUS 1. MELLICHAMPIA

Cynanchum jaliscanum (Vail) Woodson, comb. nov.

Rouliniella jaliscana Vail, Bull. Torrey Club **29**: 668. 1902.

CYNANCHUM **jamaicense** (Griseb.) Woodson, comb. nov.
Enslenia jamaicensis Griseb. Fl. B.W.I. 418. 1861.
Rouliniella jamaicensis (Griseb.) Rendle, Journ. Bot. **74**: 340. 1936.

CYNANCHUM **lignosum** (Vail) Woodson, comb. nov.
Rouliniella lignosa Vail, Bull. Torrey Club **29**: 666. 1902.

CYNANCHUM **ligulatum** (Benth.) Woodson, comb. nov.
Enslenia ligulata Benth. Pl. Hartw. 290. 1848.
Mellichampia rubescens A.Gray, Proc. Amer. Acad. **22**: 437. 1887.
Ampelamus ligulatus (Benth.) Heller, Contr. Herb. Franklin & Marshall Coll. **1**: 79. 1895.
Mellichampia ligulata (Benth.) Vail, Bull. Torrey Club **26**: 425. 1899.
Roulinia ligulata (Benth.) Pittier, Contr. U.S. Nat. Herb. **13**: 111. 1910, as to synonymy.

CYNANCHUM **Rensoni** (Pittier) Woodson, comb. nov.
Roulinia Rensoni Pittier, Contr. U.S. Nat. Herb. **13**: 101. 1910.

CYNANCHUM **saepimentorum** (Brandg.) Woodson, comb. nov.
Vincetoxicum saepimentorum Brandg. Univ. Cal. Publ. Bot. **4**: 381. 1913.

CYNANCHUM **sinaloense** (Brandg.) Woodson, comb. nov.
Roulinia sinaloensis Brandg. Zoe **5**: 243. 1908.
Mellichampia sinaloensis (Brandg.) Kearney & Peebles, Journ. Wash. Acad. Sci. **29**: 488. 1939.

CYNANCHUM **unifarium** (Scheele) Woodson, comb. nov.
Gonolobus unifarius Scheele, Linnaea **21**: 760. 1848.
Roulinia unifaria (Scheele) Engelm. in Torr. Rept. Bot. Mex. Bound. Surv. 160. 1859.
Rouliniella unifaria (Scheele) Vail, Bull. Torrey Club **29**: 663. 1902.

CYNANCHUM **Watsonianum** Woodson, nom. nov.
Roulinia Palmeri S.Wats. Proc. Amer. Acad. **18**: 115. 1883, non *Cynanchum Palmeri* (Wats.) Blake *(Pattalias Palmeri* Wats.).
Rouliniella Palmeri (S.Wats.) Vail, Bull. Torrey Club **29**: 664. 1902.

Ampelamus, Rouliniella, and *Mellichampia* can be recognized as genera only by extremely tenuous criteria. As far as I am aware, the first would have to be supported by the bifid corona segments and the rostrate stigma head; the second by a flat (or scarcely conical) stigma head and acuminate crown segments, although they are slightly emarginate in some species and not infrequently show a tendency toward the development of marginal lobules; the third would have to depend upon *somewhat* larger flowers than *Rouliniella, somewhat* more nearly campanulate corollas, and crown segments *somewhat* more united at the base. *Mellichampia* also has a stigma head intermediate between that of *Ampelamus* and that of *Rouliniella.* The crown segments of *Ampelamus* and of *Mellichampia* are flat; those of *Rouliniella* are usually *somewhat* cucullate or infolded at the base.

The primary division of the key to subgenera advocated here is one that will have to be used in some cases with a certain degree of experience, if not prejudice. Whilst the inflorescence of the *Mellichampia*-complex may be described as racemiform generally, and that of the *Metastelma*-complex as umbelliform, ambiguous species occur in both groups quite frequently enough to support my contention that it is impractical to maintain a series of distinct genera. Whilst the flowers of the *Mellichampia*-complex are smaller, as a rule, than those of the *Metastelma*-complex, this is in the nature of a guiding "prejudice" only. I have been unable to discover supporting structural characters of merit.

SUBGENUS 2. AMPELAMUS

CYNANCHUM LAEVE (Michx.) Pers. Syn. **1**: 274. 1805.
Gonolobus laevis Michx. Fl. Bor. Am. **1**: 119. 1803.
Enslenia albida Nutt. Gen. N.Am. Pl. **1**: 165. 1818.
Ampelanus albidus (Nutt.) Britton, Bull. Torrey Club **21**: 314. 1894.

The interpretation of this species has been singularly confused. In 1803 Michaux (loc. cit.) founded *Gonolobus* with three species, two of which previously had constituted the whole complement of the earlier genus *Vincetoxicum* Walt.

(Fl. Carol. 104. 1788): *G. macrophyllus (V. gonocarpos* Walt.), and *G. hirsutus (V. acanthocarpus* Walt.). The third species, *G. laevis,* originated with Michaux.

It is important in this connection to emphasize certain morphological characters of the fruit as embodied in the generic and specific descriptions by Michaux. For the genus as a whole: *"Folliculi plerumque costati seu angulosi. . ."* The follicles of the three species were described as follows: *G. macrophyllus—"folliculis costato-angulosis";* for *G. hirsutus—"folliculis oblongis, sparsim muricatis";* but for *G. laevis—"folliculis laevibus."* It is obvious that the smooth condition of the fruit of *G. laevis*—not angled as in *macrophyllus,* nor muricate as in *hirsutus*—was particularly outstanding in the estimation of Michaux, and that it suggested the specific adjective itself.

The type specimens of *G. laevis,* if they may be called such, have been examined both by Dr. Gray (Proc. Amer. Acad. Sci. **12**: 75. 1877) and by Miss Vail (Bull. Torrey Club **26**: 427. 1899), and both agreed that at least two elements are represented amongst the fragments, namely, flowers and angled fruits of *G. suberosus* (L.) R.Br.—of which *G. macrophyllus* Michx. *(G. gonocarpos* (Walt.) Perry) probably is no more than a variety—and leaves of the slender vine currently known as *Enslenia albida* Nutt. or *Ampelanus* (correctly *Ampelamus) albidus* (Nutt.) Britton. But Dr. Gray chose the flowers and fruit as authentic, whilst Miss Vail chose the leaves. At first glance Miss Vail's selection may appear to be with little foundation, until it is recalled that Michaux stipulated for his species *"folliculis laevibus,"* exactly the condition of *Ampelamus;* and that in choosing the material with angled pods, Dr. Gray denied the diagnostic character of the species. In such an instance, of obviously accidental mixture, the evident solution is to accept, as typical, material known to coincide with the original literature.

Had she studied her problem under existing rules of nomenclature, Miss Vail certainly would have placed *laevis* in a new combination under *Ampelamus.* Under the interpretations current at the New York Botanical Garden during that

time, however, she invoked the "Doctrine of Residues," returning *G. macrophyllus* and *G. hirsutus* to *Vincetoxicum* Walt., from which they had been taken by Michaux, and retaining the name *Gonolobus* for *G. laevis*.

In this connection, however, it should be noted that Michaux embodied in his diagnosis of *Gonolobus* two characters which do not coincide with the present interpretation of *G. laevis*: "*Stylus discoideo-5-gonus. . . Folliculi plerumque costati seu angulosi.*" The absence of a "Doctrine of Residues" notwithstanding, therefore, I feel that Miss Perry (Rhodora **40**: 283. 1938) is quite correct in considering the Walterian element as typical of *Gonolobus*, choosing *G. macrophyllus* as the standard species. Nevertheless, one feels that sentiment may have induced her to perpetuate Dr. Gray's interpretation of *G. laevis* rather than the more logical conclusion of Miss Vail.

Although it does not bear directly upon the question of *G. laevis*, it might be well to explain here, for future reference, that although *Vincetoxicum* Walt. clearly antedates *Gonolobus* Michx., as well as *Vincetoxicum* Moench (Meth. 717. 1794), the nomenclatorial powers at Kew, invoked by Miss Perry (loc. cit. 281–282. 1938), "temporarily" have placed *Vincetoxicum* Moench on the list of *Nomina Conservanda*, tantamount to final acceptance, since "the European Vincetoxicum is so widely used that there is every chance of its being conserved" (passage of letter by Mrs. T. A. Sprague, as quoted by Miss Perry). I suspect that the European Asclepiadologists, having had *Vincetoxicum* Moench conserved for them, will scarcely know how to use it: its distinction from *Cynanchum* is extremely evasive.

SUBGENUS 3. METALEPIS

CYNANCHUM **cubense** (Griseb.) Woodson, comb. nov.

Metalepis cubensis Griseb. Cat. Pl. Cub. 179. 1866.

The inclusion of *Metalepis* within the Gonolobeae by Schumann (in Engl. & Prantl, Nat. Pflanzenfam. **4**^{2}: 297. 1895) is a conspicuous instance of the ambiguity of the current definitions of the tribes of Asclepiadaceae. The pollinia in the species of this subgenus are quite pendulous, with the equally

rounded surfaces characteristic of the Asclepiadeae, but the translators are very long and horizontal, a condition found exactly duplicated in a few species of the subgenus *Mellichampia*. Aside from this character, the subgenus depends upon the racemiform inflorescences and the cyathiform corona, the inadequacy of which, as generic characters, has been noted previously.

SUBGENUS 4. TYLODONTIA

CYNANCHUM **Grisebachii** (Maza) Woodson, comb. nov.

Tylodontia cubensis Griseb. Cat. Pl. Cub. 179. 1866, non *Cynanchum cubense* (Griseb.) Woodson *(Metalepis cubensis* Griseb.).

Astephanus Grisebachii Maza, Cat. Periant. 276. 1894.

Tylodontia has been included as a synonym under *Astephanus* by Schumann (in Engl. & Prantl, Nat. Pflanzenfam. **4**[2]: 224. 1895), but dissection of flowers from an isotype *(Wright 2964)* in the herbarium of the Missouri Botanical Garden shows the presence of a corona of five erose, truncated scales. The subgenus is outstanding in the *Mellichampia*-complex because of the small flowers having urceolate corollas with sharply reflexed lobes.

SUBGENUS 5. METASTELMA

At present I do not feel sufficiently familiar with the synonymy of *Metastelma* to attempt the many nomenclatural changes necessary for inclusion in *Cynanchum*. This is the most difficult of the American groups of Asclepiads because the flowers are so small. Within the tiny corollas, averaging only about 2 mm. in length, are packed as many structural details and variations as within the larger flowers of other genera. Once when I was complaining to Dr. Standley of the eye and nerve strain necessary in dealing with the group, he laughingly agreed that it should be studied by an algologist or a mycologist.

Metastelma will be handled very much easier, I believe, if it is treated as a single subgenus under *Cynanchum*. Unquestionably the various entities included here are much more closely related to one another than to any other complex. The

whole aspect of the plants is so unmistakable that I feel, even with convenience particularly in mind, that "lumping" is natural as well.

As has been remarked in a previous paragraph, *Astephanus* is difficult to maintain upon a sure foundation even with the higher powers of a binocular dissecting microscope. Amongst several specimens ascribed to *A. pubescens* Greenm. in the herbarium of the Missouri Botanical Garden are two entities, one with a manifest corona and one without, the anthers of the two species differing considerably; yet the superficial aspects of the plants are all but undistinguishable. Natural genera should not be so easily confused.

Many readers may be surprised at the inclusion of *Ditassa* and *Decastelma* with *Metastelma*. But the cleaving of the corona scales or the presence of a ventral tooth or ligule, which distinguish these entities from *Metastelma* (sensu stricto), are found amongst the Old World Cynancha as well as in the *Mellichampia*-complex of Central America. Similar variation also is found in *Asclepias*.

SUBGENUS 6. CLEISTOLOBUS

CYNANCHUM **utahense** (Engelm.) Woodson, comb. nov.

Astephanus utahensis Engelm. Amer. Nat. **9**: 349. 1875.

The inflexed-cucullate corolla lobes of this species, unlike those of any other known to me, were interpreted by Dr. Engelmann as a modification to compensate for the absence of a corona.

IV. BLEPHARODON Dcne. in DC. Prodr. **8**: 603. 1844.

The nine species assigned to *Blepharodon* by Decaisne fall into two groups superficially marked by volubile or erect herbaceous habits, but accompanied by interesting differences in the corona and pollinia as well. Although I may seem inconsistent in view of my treatment of generic lines generally in this family, I feel that two distinct genera may be represented. The North American species are all of the volubile group (with the exception of *B. neriifolium* Dcne., which I believe

probably will be found to be an *Asclepias* when the material is available for study), and since this group seems to have been more typical of the genus in the opinion of Decaisne, I am reserving the use of the generic name for that connection. In respect for the memories of the many genera that I have reduced to synonymy during these studies, I am deferring judgment on the generic status of the erect species until I have the opportunity to devote my attention to the South American Asclepiads.

V. SARCOSTEMMA R.Br. Mem. Wern. Soc. **1**: 50. 1809.

Philibertia HBK. Nov. Gen. **3**: 195. 1819.
Pentagonium Schauer, Nova Acta Acad. Caes. Leop. Nat. Cur. **19**. Suppl. 1: 364. 1843.
Zosima Phil. Sert. Mendoz. Alt. 29. 1871.
Funastrum Fourn. Ann. Sci. Nat. Bot. vi. **14**: 388. 1882.
Cystostemma Fourn. in Mart. Fl. Bras. **6**^{4}: 204. 1885.
Philibertella Vail, Bull. Torrey Club **24**: 305. 1897.
Ceramanthus Malme, Ark. Bot. **4**^{14}: 2. 1905.

A few additional synonyms will have to be added from the South American flora. I am very reluctant to disregard Schlechter's separation of *Philibertia* and *Funastrum* (in Fedde, Repert. **13**: 279–287. 1915), but feel that it is necessary to do so in order to maintain balance within the family. As far as I am aware, the only character really separating the two entities, upon the basis of present speciation, is the structure of the corolla, whether campanulate with shallow lobes in the former, or rotate with more deeply divided lobes in the latter. Other definitive structures apparently are lacking, and the striking similarity, if not identity, of the anther, pollinia, and corona characters is impressive. The high attachment of the corona bladders to the anthers, cited by Schlechter for *Philibertia,* manifestly does not hold. The annulus connecting the bladdery corona segments is usually more pronounced in *Funastrum* than in *Philibertia,* but is present in both. *Sarcostemma,* currently interpreted as including only Old World species, was erected by Robert Brown to include species now

relegated to *Funastrum* and *Philibertia* as well. I can find no tangible distinction between the three, although they were placed in different subtribes by Schumann, as has been explained previously. Few North American species have been described since the prevalence of the restricted definition of *Sarcostemma,* and only the following transfers appear to be necessary:

Sarcostemma **tomentella** (Brandg.) Woodson, comb. nov.
Philibertia tomentella Brandg. Univ. Cal. Publ. Bot. **4**: 90. 1910.

Sarcostemma **Torreyi** (A.Gray) Woodson, comb. nov.
Philibertia Torreyi A.Gray, Proc. Amer. Acad. **12**: 64. 1877.
Philibertella Torreyi (A.Gray) Vail, Bull. Torrey Club **24**: 309. 1897.
Funastrum Torreyi (A.Gray) Schltr. in Fedde, Repert. **13**: 287. 1915.

VI. Matelea Aubl. Fl. Guian. **1**: 277. *t.109.* 1775.

Hostea Willd. Sp. Pl. **1**: 1274. 1798.
Macroscepis HBK. Nov. Gen. **3**: 200. 1819.
Pherotrichis Dcne. Ann. Sci. Nat. Bot. ii. **9**: 322. 1838.
Ibatia Dcne. in DC. Prodr. **8**: 599. 1844.
Polystemma Dcne. loc. cit. 602. 1844.
Dictyanthus Dcne. loc. cit. 604. 1844.
Chthamalia Dcne. loc. cit. 605. 1844.
Ptycanthera Dcne. loc. cit. 606. 1844.
Trichosacme Zucc. Abh. Akad. Wiss. München **4**^{2}: 11. 1845.
Tympananthe Hassk. Flora **30**: 757. 1847.
Rytidoloma Turcz. Bull. Soc. Nat. Mosc. **25**^{2}: 319. 1852.
Callaeolepium Karst. Fl. Col. **2**: 123. 1865.
Poicilla Griseb. Cat. Pl. Cub. 176. 1866.
Himantostemma A.Gray, Proc. Amer. Acad. **20**: 294. 1885.
Rothrockia A.Gray, loc. cit. 295. 1885.
Tetracustelma Baill. Hist. Pl. **10**: 292. 1891.
Urostephanus Robins. & Greenm. Amer. Journ. Sci. iii. **50**: 159. 1895.

Prosthecidiscus Donn.Sm. Bot. Gaz. **25**: 149. 1898.
Labidostelma Schltr. Bull. Herb. Boiss. ii. **6**: 843. 1906.
Microdactylon Brandg. Zoe **5**: 252. 1908.
Amphorella Brandg. Univ. Cal. Publ. Bot. **4**: 91. 1910.
Poicillopsis Schltr. in Urb. Symb. Ant. **7**: 339. 1912.
Pachystelma Brandg. Univ. Cal. Publ. Bot. **7**: 330. 1920.
Cyclodon Small, Man. Fl. 1075. 1933.
Odontostephana Alexander, in Small, loc. cit. 1076. 1933.
Edisonia Small, loc. cit. 1078. 1933.
Heliostemma Woodson, Amer. Journ. Bot. **22**: 689. 1935.
Gonolobus and *Vincetoxicum* of North American authors, in large part.

To this imposing list of synonyms eventually will have to be added numerous generic names from the South American flora. Very few of these entities are strictly co-extensive, nearly all having been based upon some more or less striking variation of the corona. Loud protestations probably will be made by botanists familiar with such extremes as *Dictyanthus* and *Macroscepis* that at least those familiar genera should be allowed to stand inviolate, but I should like to lay a curse on the man who revives them without at least as much study as I have devoted. And I feel compelled to enjoin all future systematists to ponder long and deeply the intricacies of the gonoloboid corona before proposing additional novelties.

The corona of *Matelea*, as is almost universal in the Cynanchoideae, consists of a unit enation of the anther filament, fundamentally subtending an additional enation (such as the hood and horn, respectively, of most species of *Asclepias*). The outer units may be separate, essentially entire, or with variously elaborated marginal lobules; at other times they may be concrescent into an inconspicuous, fimbriate skirt at the base of the gynostegium, into a ring, or into a massive rotate disc adnate to the corolla throat. The inner units may be small appendages of the anther head stipe rather high above the outer units, or may be combined, either essentially free or completely adnate, with the outer units. The result is a kaleidoscopic medley that can be conveyed in print only by the use of critical illustrations for each of the dozens of species.

At one time during the studies which preceded this paper, an intensive study was made of the anther structure of the Gonoloboids, for I felt that the position of the anthers with respect to the stigma head (whether beneath or about the margin) would aid in the establishment of some of the favorite genera apparently doomed to synonymy. Here numerous trends were obvious, but nothing of sufficient stability for generic distinction. A long consideration of pollinium structure also was ended in rather bitter frustration.

A peculiar vegetative character which links practically all the species groups of *Matelea* (although by no means every species of the groups) is the mixed indument consisting of long eglandular hairs and short, bulbose emergences. These emergences usually appear to be somewhat glandular, and may be white, dark brown, or black. Since no other group of Asclepiads with which I am familiar possesses such an indument, with the exception of the closely neighboring *Fischeria* maintained provisionally and with some misgivings, I regard its occurrence in *Matelea* as extremely significant. I am convinced that the elements which I have included in that genus are inextricably related.

Heretofore, *Matelea* has been a genus of perhaps four South American species poorly represented in North American herbaria. Its expansion as advocated here consequently entails a shocking number of new combinations. Only a few of the generic synonyms (such as *Macroscepis* and *Dictyanthus)* contain as many as half a dozen species, however, and in view of that fact and the many nomenclatural changes necessary in any event it seems scarcely worth while to ask conservation for any of those names. Then, too, such a drastic reformation may better be served by a poorly known generic name than by one with more definitely established associations.

Recent tropical American collections are bringing to light more novelties in *Matelea* than perhaps in any other genus of Asclepiads. Therefore I have prepared the following key to subgenera and sections, both to illustrate the reformation of the genus and as a temporary aid to herbarium study. I have treated several groups as subgenera simply because they have

familiar names and in spite of the fact that their characters are less important than certain others which are treated as sections, having no previous generic name (for I am wary of treating them as nouns lest some floristic student raise them to genera). As accumulation of Asclepiads from tropical North America proceeds, additional entries will have to be inserted in the key. That should accentuate the greater convenience of an ultra-conservative generic concept. As a final word, it should be emphasized that the species groups show great variation amongst their constituents, and that they cannot safely be raised to generic rank as they now exist. Certain species show affinities for more than one group. Where I have made an arbitrary disposition in such cases I usually have included notes or references to aid their identification.

KEY TO THE SUBGENERA AND SECTIONS

A. **Pollinia more or less descending from the translator arms.**

B. **Corolla subcampanulate-rotate, without a faucal annulus, the limb** merely continuing the dilation of the throat and much longer than it; corona annular, the 5 constituent segments usually distinctly 3-lobed; pollinia frequently prolonged beyond the attachment of the translator arms, excavated on one face only.....1. IBATIA

BB. **Corolla very broadly campanulate, the lobes very broad and scarcely as long as the shallow open throat, without a faucal annulus; corona rotate, of 5 segments consisting of 2 falcate outer lobes and a median inflexed lobule; pollinia conspicuously excavated on both faces**.....2. LABIDOSTELMA

BBB. **Corolla salverform-rotate, usually with a faucal annulus, the limb abruptly spreading or somewhat reflexed from the short tube.**

C. **Corolla lobes without caudate appendages; corona of 5 digitate segments adnate to the corolla tube, each with a more or less distinct callous boss supporting the stigma head; pollinia without apical processes; plants variously pubescent, but not white-woolly**.....3. MACROSCEPIS

CC. **Corolla lobes with long plumose caudate appendages; corona annular, shallowly 5-lobed, each lobe with an inconspicuous internal ligule; pollinia with a slender apical process; entire plant very densely white-woolly**.....4. TRICHOSACME

AA. **Pollinia essentially horizontal, but occasionally arcuate, with the tips somewhat ascending or descending.**

B. **Antillean species (corolla rotate; if deeply campanulate, see *Pachystelma*).**

C. Corona of 5 broad barely united segments each bearing a conspicuous incurved hook or ligule; anther head very shortly stipitate .....5. POICILLA
CC. Corona not as above.....6. PTYCANTHERA
D. Anther head distinctly stipitate.....§. *Pauciflorae*
DD. Anther head absolutely sessile.....§. *Variifoliae*
BB. Continental species.
C. Pollinia subquadrate- or oblong-reniform with a narrow hyaline margin; corona of 5 more or less united segments each with an internal ligule or boss.....7. CHTHAMALIA
CC. Pollinia falciform or arcuate, the tips markedly ascending, hyaline margins or indentations inconspicuous or lacking.
D. Erect or prostrate herbs; corolla lobes ascending.
E. Corolla rotate-subcampanulate, the orifice not constricted; corona segments not strongly adnate to the corolla throat .....8. PHEROTRICHIS
EE. Corolla urceolate-campanulate, the orifice markedly constricted; corona strongly adnate to the corolla throat...9. AMPHORELLA
DD. Lianas or twining undershrubs (except *M. caudata);* corolla lobes reflexed or spreading.
E. Corolla rotate, with long narrow ascending lobes; corona of 5 nearly separate pectinate segments; anther head with a definite appendiculate stipe.....10. TIARASTEMMA
EE. Corolla deeply campanulate, with relatively broad ascending lobes; corona of 5 fimbriately compound segments; anther head sessile.....11. POLYSTEMMA
EEE. Corolla subcampanulate-rotate, with relatively broad widely spreading or reflexed lobes; corona of 5 broad, more or less carunculate segments usually strongly adnate to the corolla throat; anther head sessile.....12. HELIOSTEMMA
CCC. Pollinia subtriangular-pyriform, with a conspicuous hyaline indentation or margin and broad winged translator arms.
D. Corolla rotate to subcampanulate-rotate; anther head round to very broadly 5-gonal; corona more or less annular or rotate..... .....13. EUMATELEA
E. Corolla without a faucal annulus exterior to the true corona.
F. Anther head with a strongly manifest fluted stipe..§. *Reticulatae*
FF. Anther head essentially sessile; corona with 5 broad partitions superposed.
G. Corona light and intricately fimbriate.....§. *Violaceae*
GG. Corona dark and carunculate.....§. *Pseudobarbatae*
EE. Corolla throat with an interrupted 5-angled faucal annulus exterior to the true corona.....§. *Viridiflorae*
DD. Corolla deeply campanulate; anther head saliently 5-gonal; corona of 5 simple or compound digitate segments.
E. Corona segments digitately compound, adnate to the column but essentially free from the corolla; corolla lobes strikingly pilose-barbate within.....14. MICRODACTYLON

EE. Corona segments simply digitate or merely somewhat caruncu-
late, adnate to the corolla throat at least at the base; corolla
lobes essentially glabrous within.
F. Corona lobes relatively short and thick, adnate to the corolla
only at the base; corolla lobes flat.....15. PACHYSTELMA
FF. Corona lobes long and narrow, wholly adnate to the corolla
throat and imbedded in similarly shaped fleshy corolline
excrescences; corolla lobes sharply revolute, especially at
the base.....16. DICTYANTHUS

SUBGENUS 1. IBATIA

Matelea **araneosus** (Donn.Sm.) Woodson, comb. nov.
Gonolobus araneosus Donn.Sm. Bot. Gaz. **47**: 257. 1909.

Matelea **atrocoronata** (Brandg.) Woodson, comb. nov.
Vincetoxicum atrocoronatum Brandg. Univ. Cal. Publ. Bot. **6**: 372. 1917.

Matelea **chrysantha** (Greenm.) Woodson, comb. nov.
Gonolobus chrysanthus Greenm. Proc. Amer. Acad. **32**: 299. 1897.
Vincetoxicum chrysanthum (Greenm.) Standl. Contr. U.S. Nat. Herb. **23**: 1190. 1924.

Matelea **cordifolia** (A.Gray) Woodson, comb. nov.
Rothrockia cordifolia A.Gray, Proc. Amer. Acad. **20**: 295. 1885.

Matelea **fruticosa** (Brandg.) Woodson, comb. nov.
Rothrockia fruticosa Brandg. Zoe **5**: 165. 1903.

Matelea **gonoloboides** (Robins. & Greenm.) Woodson, comb. nov.
Urostephanus gonoloboides Robins. & Greenm. Amer. Journ. Sci. iii. **50**: 159. 1895.

Matelea **inconspicua** (Brandg.) Woodson, comb. nov.
Gonolobus inconspicuus Brandg. Univ. Cal. Publ. Bot. **3**: 387. 1909.

Matelea **maritima** (Jacq.) Woodson, comb. nov.
Cynanchum maritimum Jacq. Stirp. Amer. 83. *pl.56.* 1763.
Gonolobus maritimus (Jacq.) R.Br. Mem. Wern. Soc. **1**: 35. 1809.
Gonolobus floccosus Bertol. Opusc. **4**: 521. 1823.
Gonolobus suberosus Spreng. Syst. **1**: 846. 1825, non R.Br.

Ibatia maritima (Jacq.) Dene. in DC. Prodr. **8**: 599. 1844.
Lachnostoma maritimum (Jacq.) Nichols. Dict. Gard. **2**: 236. 1884.
Ibatia muricata Griseb. Fl. B.W.I. 421. 1861.

MATELEA **mollis** (Griseb.) Woodson, comb. nov.
Ibatia mollis Griseb. Cat. Pl. Cub. 177. 1866.
Lachnostoma molle (Griseb.) Maza, Cat. Periant. 276. 1894.
Ptychanthera mollis (Griseb.) Schltr. in Urb. Symb. Ant. **1**: 280. 1899.

MATELEA **patalensis** (Donn.Sm.) Woodson, comb. nov.
Gonolobus patalensis Donn.Sm. Bot. Gaz. **47**: 256. 1909.

MATELEA **petiolaris** (A.Gray) Woodson, comb. nov.
Gonolobus petiolaris A.Gray, Proc. Amer. Acad. **21**: 397. 1886.
Vincetoxicum petiolare (A.Gray) Standl. Contr. U.S. Nat. Herb. **23**: 1189. 1924.

MATELEA **porphyrantha** (Standl.) Woodson, comb. nov.
Vincetoxicum porphyranthum Standl. ex Yuncker, Field Mus. Publ. Bot. **17**: 387. 1938.

MATELEA **Pringlei** (A.Gray) Woodson, comb. nov.
Himantostemma Pringlei A.Gray, Proc. Amer. Acad. **20**: 294. 1885.

MATELEA **Prosthecidiscus** Woodson, nom. nov.
Prosthecidiscus guatemalensis Donn.Sm. Bot. Gaz. **25**: 150. *pl.12.* 1898, non *Matelea guatemalensis* (K.Sch.) Woodson.

MATELEA **pueblensis** (Brandg.) Woodson, comb. nov.
Vincetoxicum pueblensis Brandg. Univ. Cal. Publ. Bot. **4**: 91. 1910.

MATELEA **Purpusii** (Brandg.) Woodson, comb. nov.
Gonolobus Purpusii Brandg. Univ. Calif. Publ. Bot. **3**: 387. 1909.

MATELEA **tristiflora** (Standl.) Woodson, comb. nov.
Vincetoxicum tristiflorum Standl. Field Mus. Publ. Bot. **17**: 272. 1937.

MATELEA **umbellata** (Brandg.) Woodson, comb. nov.
Rothrockia umbellata Brandg. Zoe **5**: 165. 1903.

MATELEA **Warscewiczii** (Karst.) Woodson, comb. nov.
Callaeolepium Warscewiczii Karst. Fl. Col. **2**: 123. *pl. 165*. 1865.
Fimbristemma Warscewiczii (Karst.) Benth. & Hook. Gen. Pl. **2**: 768. 1876.

Ibatia is placed in the key as having "pendulous" pollinia since their vertical dimension is at least equal to the horizontal and usually is greater. Some confusion with *Chthamalia* is likely to occur, but may be avoided by a comparison of the coronas, that of the former subgenus being without internal ligules or bosses adnate to the segments and that of the latter always having such structures.

SUBGENUS 2. LABIDOSTELMA

MATELEA **Quirosii** (Standl.) Woodson, comb. nov.
Cynanchum rotatum Sesse & Mociño, Fl. Mex. 76. 1887, non Vell.
Labidostelma guatemalense Schltr. Bull. Herb. Boiss. ii. **6**: 843. 1906, non *M. guatemalensis* (Donn.Sm.) Woodson.
Vincetoxicum Quirosii Standl. Field Mus. Publ. Bot. **18**[3]: 959. 1938.

SUBGENUS 3. MACROSCEPIS

MATELEA **calcicola** (Greenm.) Woodson, comb. nov.
Gonolobus calcicola Greenm. Proc. Amer. Acad. **40**: 30. 1904.
Vincetoxicum calcicola (Greenm.) Standl. Contr. U.S. Nat. Herb. **23**: 1191. 1924.

MATELEA **congesta** (Dcne.) Woodson, comb. nov.
Gonolobus congestus Dcne. in DC. Prodr. **8**: 597. 1844.
Vincetoxicum congestum (Dcne.) Standl. Contr. U.S. Nat. Herb. **23**: 1189. 1924.

MATELEA **congestiflora** (Donn.Sm.) Woodson, comb. nov.
Cynanchum hirsutum Sesse & Mociño, Fl. Mex. 76. 1887, non Vell.
Macroscepis congestiflora Donn.Sm. Bot. Gaz. **25**: 149. 1898.

MATELEA **diademata** (Edwards) Woodson, comb. nov.
Gonolobus diadematus Edwards, Bot. Reg. **3**: *pl.252.* 1817.
Vincetoxicum diadematum (Edwards) Standl. Contr. U.S. Nat. Herb. **23**: 1188. 1924.

MATELEA **magnifolia** (Pittier) Woodson, comb. nov.
Gonolobus magnifolius Pittier, Contr. U.S. Nat. Herb. **13**: 104. *fig.13.* 1910.
Vincetoxicum magnifolium (Pittier) Standl. loc. cit. **23**: 1188. 1924.

MATELEA **obovata** (HBK.) Woodson, comb. nov.
Macroscepis obovata HBK. Nov. Gen. **3**: 200. 1819.

SUBGENUS 4. TRICHOSACME

MATELEA **lanata** (Zucc.) Woodson, comb. nov.
Trichosacme lanata Zucc. Abh. Akad. Wiss. Munchen **4**[2]: 11. 1845.

An explanation, if not an apology, is in order for reducing *Trichosacme* from generic status. *M. lanata* is quite unmistakable because of the copius lanate pubescence and long plumose corolla lobes; but aside from these particulars it is manifestly intermediate between other groups, having somewhat the corona of *Chthamalia,* the pollinia of *Ibatia,* and the corolla (except the lobe appendages) of a miniature *Macroscepis.*

SUBGENUS 5. POICILLA

MATELEA **ovatifolia** (Griseb.) Woodson, comb. nov.
Poicilla ovatifolia Griseb. Cat. Pl. Cub. 177. 1866.
Ptychanthera ovatifolia (Griseb.) Schltr. in Urb. Symb. Ant. **1**: 279. 1899.

MATELEA **tamnifolia** (Griseb.) Woodson, comb. nov.
Poicilla tamnifolia Griseb. Cat. Pl. Cub. 176. 1866.

SUBGENUS 6. PTYCANTHERA

§. *Pauciflorae*

MATELEA **acuminata** (Griseb.) Woodson, comb. nov.
Orthosia acuminata Griseb. Cat. Pl. Cub. 175. 1866.
Ptychanthera Berterii acc. to Schltr. in Urb. Symb. Ant. **1**: 279. 1899, non Dcne.

Poicilla acuminata (Griseb.) Schltr. loc. cit. **5**: 469. 1908.

Poicillopsis acuminata (Griseb.) Schltr. loc. cit. **7**: 339. 1912.

MATELEA **nipensis** (Urb.) Woodson, comb. nov.

Gonolobus nipensis Urb. Symb. Ant. **9**: 421. 1925.

MATELEA **oblongata** (Griseb.) Woodson, comb. nov.

Orthosia oblongata Griseb. Cat. Pl. Cub. 176. 1866.

Ptychanthera oblongata (Griseb.) Schltr. in Urb. Symb. Ant. **1**: 280. 1899.

Poicilla oblongata (Griseb.) Schltr. loc. cit. **5**: 470. 1908.

Poicillopsis oblongata (Griseb.) Schltr. loc. cit. **7**: 339. 1912.

MATELEA **pauciflora** (Spreng.) Woodson, comb. nov.

Gonolobus pauciflorus Spreng. Syst. **1**: 846. 1825.

Ptycanthera Berterii Dcne. in DC. Prodr. **8**: 606. 1844, not acc. to Schltr. in Urb. Symb. Ant. **1**: 279. 1899.

§. *Variifoliae*

MATELEA **bayatensis** (Urb.) Woodson, comb. nov.

Gonolobus bayatensis Urb. Symb. Ant. **9**: 420. 1925.

MATELEA **Ekmanii** (Urb.) Woodson, comb. nov.

Gonolobus Ekmanii Urb. Symb. Ant. **9**: 422. 1925.

MATELEA **Sintenisii** (Schltr.) Woodson, comb. nov.

Gonolobus Sintenisii Schltr. in Urb. Symb. Ant. **1**: 288. 1899.

Vincetoxicum Sintenisii (Schltr.) Britton, Sci. Surv. Porto Rico & Virgin Isl. **6**: 100. 1925.

MATELEA **tigrina** (Griseb.) Woodson, comb. nov.

Gonolobus tigrinus Griseb. Pl. Wright. 520. 1862.

MATELEA **variifolia** (Schltr.) Woodson, comb. nov.

Gonolobus variifolius Schltr. in Urb. Symb. Ant. **1**: 286. 1899.

Vincetoxicum variifolium (Schltr.) Britton, Sci. Surv. Porto Rico & Virgin Isl. **6**: 100. 1925.

The subgenus *Ptycanthera* was largely the deciding factor in the inclusive treatment of *Matelea* which I have adopted.

Were it not for the Antillean species, one might compose a fairly respectable key to several genera upon the continent, following generally the lines of the key to subgenera and sections of *Matelea* as it now appears. However, the Antillean species cut so sharply across most of the distinctions between the continental groups that the only way I can distinguish them from the latter in print is by the geographical factor. Were it not for their ambiguity with respect to the continental entities, one might obliterate *Ptycanthera* entirely, distributing §. *Pauciflorae* and §. *Variifoliae,* perhaps, to the continental subgenera *Eumatelea* and *Heliostemma* respectively.

Variation of the corona in *Ptycanthera* appears largely to be responsive to the development of the anther head stipe. Where the latter is fairly pronounced, in § *Pauciflorae,* the corona adopts much the same fluted appearance with subtending skirt as in *Eumatelea* § *Reticulatae;* but where the anther head is sessile *(§ Variifoliae),* the corona becomes a rotate disc as in *Heliostemma,* or a shallow 5-angled ring, in either case with 5 partitions, bosses, or hooks corresponding to the fluted buttresses of § *Pauciflorae.* In *M. Sintenisii* the compression of the anther head and corona apparently has led to the formation by the corolla throat of a rather prominent faucal annulus. The anther and pollinium structures are somewhat more variable even than in the continental species.

Yet, withal, the superficial aspect of the various species is so similar in most cases that I cannot but view them as extremely closely related, particularly in view of their restricted geographical distribution. The exasperations attendant upon their attempted segregation are illustrated graphically by Schlechter's vacillation between *Poicilla, Ptycanthera* (spelled *Ptychanthera* by him), *Poicillopsis,* and *Gonolobus,* with the familiar *Vincetoxicum-motif* supplied by Dr. Britton.

SUBGENUS 7. CHTHAMALIA

MATELEA **adenocardium** (Standl.) Woodson, comb. nov.

Vincetoxicum adenocardium Standl. Field Mus. Publ. Bot. **17**: 267. 1937.

MATELEA **Baldwyniana** (Sweet) Woodson, comb. nov.

Gonolobus Baldwynianus Sweet, Hort. Brit. ed.2. 360. 1830.

Vincetoxicum Baldwinianum (Sweet) Britton, Mem. Torrey Club **5**: 265. 1894.

Odontostephana Baldwiniana (Sweet) Alexander, in Small, Man. Fl. 1077. 1933.

MATELEA **biflora** (Raf.) Woodson, comb. nov.

Gonolobus biflorus Raf. New Fl. N. Amer. 4: 58. 1836.

Chthamalia biflora (Raf.) Dcne. in DC. Prodr. **8**: 605. 1844.

Vincetoxicum biflorum (Raf.) Heller, Contr. Herb. Franklin & Marshall Coll. **1**: 79. 1895.

MATELEA **brevicoronata** (Robins.) Woodson, comb. nov.

Gonolobus parviflorus var. *brevicoronatus* Robins. Proc. Amer. Acad. **26**: 169. 1891.

MATELEA **camporum** (Brandg.) Woodson, comb. nov.

Vincetoxicum camporum Brandg. Univ. Calif. Publ. Bot. **4**: 185. 1911.

MATELEA **carolinensis** (Jacq.) Woodson, comb. nov.

Cynanchum carolinense Jacq. Coll. **2**: 288. 1788.

Gonolobus carolinensis (Jacq.) R.Br. Mem. Wern. Soc. **1**: 35. 1809.

Vincetoxicum carolinense (Jacq.) Britton, Mem. Torrey Club **5**: 265. 1894.

Odontostephana carolinensis (Jacq.) Alexander, in Small, Man. Fl. 1077. 1933.

MATELEA **cynanchoides** (Engelm.) Woodson, comb. nov.

Gonolobus cynanchoides Engelm. in Engelm. & Gray, Boston Journ. Nat. Hist. **5**: 251. 1845.

Vincetoxicum cynanchoides (Engelm.) Heller, Muhlenbergia **1**: 2. 1900.

MATELEA **decipiens** (Alexander) Woodson, comb. nov.

Odontostephana decipiens Alexander, in Small, Man. Fl. 1077. 1933.

Gonolobus decipiens (Alexander) Perry, Rhodora **40**: 286. 1938.

MATELEA **flavidula** (Chapm.) Woodson, comb. nov.

Gonolobus flavidulus Chapm. Bot. Gaz. **3**: 12. 1878.

Gonolobus hirsutus var. *flavidulus* (Chapm.) A.Gray, Syn. Fl. ed.2, **2**[1]: 404. 1886.
Vincetoxicum flavidulum (Chapm.) Heller, Muhlenbergia **1**: 2. 1900.
Odontostephana flavidula (Chapm.) Alexander, in Small, Man. Fl. 1078. 1933.

MATELEA **floridana** (Vail) Woodson, comb. nov.
Vincetoxicum floridanum Vail, Bull. Torrey Club **26**: 428. 1899.
Odontostephana floridana (Vail) Alexander, in Small, Man. Fl. 1078. 1933.

MATELEA **Greggii** (Vail) Woodson, comb. nov.
Vincetoxicum Greggii Vail, Bull. Torrey Club **26**: 431. 1899.

MATELEA **LeSueurii** (Standl.) Woodson, comb. nov.
Vincetoxicum LeSueurii Standl. Field Mus. Publ. Bot. **17**: 270. 1937.

The pollinia of this species are not the subquadrate-reniform sort typical of *Chthamalia,* but are more nearly triangular-pyriform. Nevertheless, the affinities of *M. LeSueurii* unmistakably are with that subgenus, particularly with *M. Nummularia.*

MATELEA **Nummularia** (Dcne.) Woodson, comb. nov.
Chthamalia Nummularia Dcne. in DC. Prodr. **8**: 605. 1844.

MATELEA **obliqua** (Jacq.) Woodson, comb. nov.
Cynanchum obliquum Jacq. Coll. **1**: 148. 1786.
Gonolobus obliquus (Jacq.) R.Br. Mem. Wern. Soc. **1**: 35. 1809.
Vincetoxicum obliquum (Jacq.) Britton, Mem. Torrey Club **5**: 266. 1894.
Odontostephana obliqua (Jacq.) Alexander, in Small, Man. Fl. 1077. 1933.

MATELEA **parviflora** (Torr.) Woodson, comb. nov.
Lachnostoma (?) parviflorum Torr. Rept. Bot. Mex. Bound. Surv. 165. 1859.
Gonolobus parviflorus (Torr.) A.Gray, Proc. Amer. Acad. **12**: 79. 1877.

Vincetoxicum parviflorum (Torr.) Heller, Muhlenbergia **1**: 2. 1900.

MATELEA **parvifolia** (Torr.) Woodson, comb. nov.

Gonolobus parvifolius Torr. Rept. Bot. Mex. Bound. Surv. 166. 1859.

Gonolobus hastulatus A.Gray, Proc. Amer. Acad. **12**: 78. 1877.

Vincetoxicum hastulatum (A.Gray) Heller, Muhlenbergia **1**: 2. 1900.

Gonolobus californicus Jepson, Man. 771. 1925.

MATELEA **pedunculata** (Dcne.) Woodson, comb. nov.

Chthamalia pedunculata Dcne. in DC. Prodr. **8**: 605. 1844.

MATELEA **producta** (Torr.) Woodson, comb. nov.

Gonolobus productus Torr. Rept. Bot. Mex. Bound. Surv. 165. 1859.

Vincetoxicum productum (Torr.) Vail, Bull. Torrey Club **26**: 431. 1899.

MATELEA **prostrata** (Willd.) Woodson, comb. nov.

Cynanchum prostratum Willd. Sp. Pl. **1**: 1257. 1798.

Gonolobus prostratus (Willd.) R.Br. Mem. Wern. Soc. **1**: 35. 1809.

Lachnostoma prostratum (Willd.) Dcne. in DC. Prodr. **8**: 602. 1844.

Tetracustelma prostrata (Willd.) Baill. Hist. Pl. **10**: 292. 1891.

MATELEA **pubiflora** (Dcne.) Woodson, comb. nov.

Chthamalia pubiflora Dcne. in DC. Prodr. **8**: 605. 1844.

Gonolobus pubiflorus (Dcne.) Engelm. in Engelm. & Gray, Boston Journ. Nat. Hist. **5**: 252. 1845.

Vincetoxicum pubiflorum (Dcne.) Heller, Muhlenbergia **1**: 2. 1900.

Edisonia pubiflora (Dcne.) Small, Man. Fl. 1078. 1933.

MATELEA **Schaffneri** (A.Gray) Woodson, comb. nov.

Gonolobus Schaffneri A.Gray, in Hemsl. Biol. Centr.-Am. Bot. **2**: 334. 1882; A.Gray, Proc. Amer. Acad. **21**: 399. 1886.

Gonolobus bifidus Hemsl. Biol. Centr.-Amer. Bot. **2**: 330. 1882.

MATELEA **Shortii** (A.Gray) Woodson, comb. nov.
Gonolobus obliquus var. *Shortii* A.Gray, Syn. Fl. **2**[1]: 104. 1878.
Vincetoxicum Shortii (A.Gray) Britton, Mem. Torrey Club **5**: 266. 1894.
Gonolobus Shortii A.Gray, Bot. Gaz. **8**: 191. 1883.
Odontostephana Shortii (A.Gray) Alexander, in Small, Man. Fl. 1077. 1933.

MATELEA **stenopetala** (A.Gray) Woodson, comb. nov.
Gonolobus stenopetalus A.Gray, Proc. Amer. Acad. **21**: 398. 1886.
Vincetoxicum stenopetalum (A.Gray) Standl. Contr. U.S. Nat. Herb. **23**: 1190. 1924.

MATELEA **Vailiana** Woodson, nom. nov.
Gonolobus acuminatus A.Gray, Proc. Amer. Acad. **21**: 399. 1886, non *Matelea acuminata* (Griseb.) Woodson.
Vincetoxicum acuminatum (A.Gray) Vail, Bull. Torrey Club **26**: 431. 1899.

MATELEA **Wootonii** (Vail) Woodson, comb. nov.
Vincetoxicum Wootonii Vail, Bull. Torrey Club **28**: 485. *pl.30.* 1901.

This is the characteristic group of *Matelea* in northern Mexico and the southern United States. The pollinia are well illustrated for the species "in the Manual Range" by Miss Perry (Rhodora **40**: *pl.494.* 1938) where the contrasting features of true *Gonolobus* pollinia are shown also. I believe that *Chthamalia* is perhaps most closely related to *Ibatia* amongst the subgenera of *Matelea,* the "pendulous" pollinia of the latter frequently appearing much like the "horizontal" pollinia of the former (merely of greater vertical dimension). The corona of the two subgenera, also, are much alike, but the internal ligules of the former are merely adnate (sometimes nearly free) to the outer segments, whereas the fusion is virtually complete in the latter.

SUBGENUS 8. PHEROTRICHIS

MATELEA **Balbisii** (Dcne.) Woodson, comb. nov.

Asclepias villosa Balb. Mem. Accad. Sci. Torino **7**: 386. 1803, non Mill.
Cynanchum villosum (Balb.) R. & S. Syst. **6**: 103. 1819.
Lachnostoma Balbisii Dcne. in DC. Prodr. **8**: 602. 1844.
Gonolobus pogonanthus Hemsl. Biol. Centr.-Am. Bot. **2**: 333. 1882.
Pherotrichis Balbisii (Dcne.) A.Gray, Proc. Amer. Acad. **21**: 400. 1886; Syn. Fl. ed.2. **2**[1]: 462. 1886.
Pherotrichis Schaffneri A.Gray, loc. cit. 1886.

MATELEA **chihuahuensis** (A.Gray) Woodson, comb. nov.
Gonolobus chihuahuensis A.Gray, Proc. Amer. Acad. **21**: 398. 1886.
Vincetoxicum chihuahuense (A.Gray) Standl. Field Mus. Publ. Bot. **17**: 270. 1937.

MATELEA **leptogenia** (Robins.) Woodson, comb. nov.
Pherotrichis leptogenia Robins. Proc. Amer. Acad. **29**: 319. 1894.

SUBGENUS 9. AMPHORELLA

MATELEA **castanea** (Brandg.) Woodson, comb. nov.
Amphorella castanea Brandg. Univ. Calif. Publ. Bot. **4**: 92. 1910.

SUBGENUS 10. TIARASTEMMA

MATELEA **calcarata** Woodson, comb. nov.
Vincetoxicum calcaratum Woodson, Amer. Journ. Bot. **22**: 689. *pl.1. fig.8*. 1935.

MATELEA **belizensis** (Lundell & Standl.) Woodson, comb. nov.
Vincetoxicum belizense Lundell & Standl. in Standl. Field Mus. Publ. Bot. **17**: 268. 1937.

SUBGENUS 11. POLYSTEMMA

MATELEA **Decaisnei** Woodson, nom. nov.
Polystemma viridiflora Dcne. in DC. Prodr. **8**: 602. 1844, non *M. viridiflora* (G.F.W.Mey.) Woodson.

MATELEA **rupestris** (Brandg.) Woodson, comb. nov.
Polystemma rupestre Brandg. Univ. Cal. Publ. Bot. **7**: 330. 1920.

MATELEA **scopulorum** (Brandg.) Woodson, comb. nov.

Polystemma scopulorum Brandg. Univ. Calif. Publ. Bot. **6**: 189. 1915.

SUBGENUS 12. HELIOSTEMMA

MATELEA **caudata** (A.Gray) Woodson, comb. nov.

Gonolobus caudatus A.Gray, Proc. Amer. Acad. **21**: 399. 1886.

Vincetoxicum caudatum (A.Gray) Standl. Contr. U.S. Nat. Herb. **23**: 1190. 1924.

MATELEA **crenata** (Vail) Woodson, comb. nov.

Vincetoxicum crenatum Vail, Bull. Torrey Club **26**: 429. 1899.

This species might almost as well be placed in *Ibatia* upon the basis of the pollinia alone, for they are only slightly falciform. The corona segments, also, are scarcely typical of *Heliostemma* in that they are not strongly adnate to the corolla throat. However, they do have a conspicuous internal boss which is characteristic of the latter subgenus and never found in the former.

MATELEA **cyclophylla** (Standl.) Woodson, comb. nov.

Vincetoxicum cyclophyllum Standl. Contr. U.S. Nat. Herb. **23**: 1191. 1924.

MATELEA **nigrescens** (Schlecht.) Woodson, comb. nov.

Gonolobus nigrescens Schlecht. Linnaea **8**: 522. 1833.

Vincetoxicum nigrescens (Schlecht.) Standl. Contr. U.S. Nat. Herb. **23**: 1192. 1924.

MATELEA **picturata** (Hemsl.) Woodson, comb. nov.

Gonolobus picturatus Hemsl. Biol. Centr.-Am. Bot. **2**: 332. 1882.

MATELEA **pilosa** (Benth.) Woodson, comb. nov.

Gonolobus pilosus Benth. Pl. Hartw. 289. 1848.

Gonolobus atratus A.Gray, Proc. Amer. Acad. **22**: 436. 1887.

Gonolobus suberiferus Robins. Proc. Amer. Acad. **27**: 181. 1892.

Vincetoxicum Grayanum Standl. Contr. U.S. Nat. Herb. **23**: 1191. 1924.

Vincetoxicum pilosum (Benth.) Standl. loc. cit. 1924.
Vincetoxicum suberiferum (Robins.) Standl. loc. cit. 1189. 1924.
Vincetoxicum quercetorum Standl. Field Mus. Publ. Bot. **17**: 271. 1937.

MATELEA **Pittieri** (Standl.) Woodson, comb. nov.
Vincetoxicum Pittieri Standl. Field Mus. Publ. Bot. **17**: 270. 1937.
Vincetoxicum discolor Woodson, Ann. Missouri Bot. Gard. **25**: 833. *fig.1.* 1938.

SUBGENUS 13. EUMATELEA

§. *Reticulatae*

MATELEA **alabamensis** (Vail) Woodson, comb. nov.
Vincetoxicum alabamense Vail, Bull. Torrey Club **30**: 178. *pl.9.* 1903.

MATELEA **campechiana** (Standl.) Woodson, comb. nov.
Vincetoxicum campechianum Standl. Carnegie Inst. Wash. Publ. 461: 82. 1935.

MATELEA **Gentlei** (Lundell & Standl.) Woodson, comb. nov.
Vincetoxicum Gentlei Lundell & Standl. Field Mus. Publ. Bot. **17**: 269. 1937.

MATELEA **lanceolata** (Dcne.) Woodson, comb. nov.
Gonolobus lanceolatus Dcne. in DC. Prodr. **8**: 598. 1844.
Vincetoxicum stenophyllum Standl. Contr. U.S. Nat. Herb. **23**: 1188. 1924.

MATELEA **reticulata** (Engelm.) Woodson, comb. nov.
Gonolobus reticulatus Engelm. ex A.Gray, Proc. Amer. Acad. **12**: 75. 1877.
Vincetoxicum reticulatum (Engelm.) Heller, Bot. Expl. Texas, 79. 1895.

MATELEA **Tuerckheimii** (Donn.Sm.) Woodson, comb. nov.
Gonolobus Tuerckheimii Donn. Sm. Bot. Gaz. **44**: 116. 1907.
Vincetoxicum trichoneuron Standl. ex Yuncker, Field Mus. Publ. Bot. **17**: 388. 1938.

MATELEA **velutina** (Schlecht.) Woodson, comb. nov.
Gonolobus velutinus Schlecht. Linnaea **8**: 521. 1833.

Vincetoxicum velutinum (Schlecht.) Standl. Contr. U.S. Nat. Herb. **23**: 1189. 1924.

§. *Pseudobarbatae*

MATELEA **guatemalensis** (K.Sch.) Woodson, comb. nov.

Gonolobus velutinus var. *calycinus* Donn.Sm. Bot. Gaz. **13**: 189. 1888.

Gonolobus guatemalensis K.Sch. in Engl. & Prantl, Nat. Pflanzenfam. **4²**: 302. 1895.

MATELEA **pinguifolia** (Standl.) Woodson, comb. nov.

Vincetoxicum pinguifolium Standl. Journ. Wash. Acad. Sci. **17**: 13. 1927.

MATELEA **pseudobarbata** (Pittier) Woodson, comb. nov.

Gonolobus pseudobarbatus Pittier, Contr. U.S. Nat. Herb. **13**: 105. *fig.14.* 1910.

Matelea nigrescens shows a strong affinity with this section, but has been placed in *Heliostemma* because of its falciform pollinia.

§. *Viridiflorae*

MATELEA **grandiflora** (Standl.) Woodson, comb. nov.

Vincetoxicum grandiflorum Standl. Carnegie Inst. Wash. Publ. 461: 83. 1935.

MATELEA **viridiflora** (G.F.W.Mey.) Woodson, comb. nov.

Cynanchum viridiflorum G.F.W.Mey. Prim. Fl. Esseq. 141. 1818.

Gonolobus viridiflorus (G.F.W.Mey.) R. & S. Syst. **6**: 61. 1819.

Vincetoxicum viridiflorum (G.F.W.Mey.) Standl. Contr. U.S. Nat. Herb. **27**: 311. 1928.

This little group illustrates the maddening complications that result from attempts at segregation in the Gonolobeae. *M. viridiflora* and *M. grandiflora* quite obviously are very closely related, as evidenced particularly by the interrupted corolline annulus. Other characters, however, point strongly to relationship with other groups of *Matelea,* with the exception of the pollinia, which are scarcely similar to those of *Eumatelea,* and can be construed as "triangular-pyriform"

only with a considerable stretch of the imagination. But on the other hand, the pollinia of the two species are so dissimilar that I can find no descriptive term to cover both, and at the same time to distinguish them from *Eumatelea*.

SUBGENUS 14. MICRODACTYLON

MATELEA **cordata** (Brandg.) Woodson, comb. nov.
Microdactylon cordatum Brandg. Zoe **5**: 252. 1908.

SUBGENUS 15. PACHYSTELMA

MATELEA **bicolor** (Britton & Wilson) Woodson, comb. nov.
Marsdenia bicolor Britton & Wilson, Bull. Torrey Club **50**: 47. 1923.
Gonolobus bicolor (Britton & Wilson) Urb. Symb. Ant. **9**: 421. 1925.

MATELEA **crassifolia** (Standl.) Woodson, comb. nov.
Vincetoxicum crassifolium Standl. Field Mus. Publ. Bot. **8**: 36. 1930.

MATELEA **megacarpha** (Brandg.) Woodson, comb. nov.
Vincetoxicum megacarphum Brandg. Univ. Cal. Publ. Bot. **4**: 381. 1913.
Pachystelma cordatum Brandg. loc. cit. **7**: 330. 1920.
Dictyanthus brachistanthus Standl. Field Mus. Publ. Bot. **8**: 38. 1930.

SUBGENUS 16. DICTYANTHUS

MATELEA **altatensis** (Brandg.) Woodson, comb. nov.
Gonolobus altatensis Brandg. Zoe **5**: 244. 1908.

MATELEA **ceratopetala** (Donn.Sm.) Woodson, comb. nov.
Dictyanthus ceratopetalus Donn.Sm. Bot. Gaz. **18**: 208. 1893.

MATELEA **dictyantha** Woodson, nom. nov.
Rytidoloma reticulata Turcz. Bull. Soc. Nat. Mosc. **25**^{2}: 320. 1852, non *Matelea reticulata* (Engelm.) Woodson.
Dictyanthus reticulatus (Turcz.) Benth. & Hook. Gen. Pl. **2**: 765. 1876.

MATELEA **diffusa** Woodson, nom. nov.
Dictyanthus prostratus Brandg. Univ. Cal. Publ. Bot. **7**: 329. 1920, non *Matelea prostrata* (Willd.) Woodson.

MATELEA **Hemsleyana** Woodson, nom. nov.
Dictyanthus parviflorus Hemsl. Biol. Centr. Am. Bot. **2**: 329. 1882, non *Matelea parviflora* (Torr.) Woodson.

MATELEA **Pavonii** (Dcne.) Woodson, comb. nov.
Dictyanthus Pavonii Dcne. in DC. Prodr. **8**: 605. 1844.
Tympananthe suberosa Hassk. Flora **30**: 758. 1847.

MATELEA **Standleyana** Woodson, nom. nov.
Dictyanthus tigrinus Conzatti & Standl. in Standl. Contr. U.S. Nat. Herb. **23**: 1183. 1924, non *Matelea tigrina* (Griseb.) Woodson.

MATELEA **stapeliaeflora** (Reichb.) Woodson, comb. nov.
Dictyanthus stapeliaeflora Reichb. Sel. Sem. Hort. Dresden, 4. 1850.

MATELEA **tuberosa** (Robins.) Woodson, comb. nov.
Dictyanthus tuberosus Robins. Proc. Amer. Acad. **27**: 180. 1892.

MATELEA **yucatanensis** (Standl.) Woodson, comb. nov.
Dictyanthus yucatanensis Standl. Field Mus. Publ. Bot. **8**: 37. 1930.
Dictyanthus aeneus Woodson, Amer. Journ. Bot. **22**: 691. 1935.

I am very reluctant to merge *Dictyanthus* with *Matelea*, since the various species here show considerably more coherence and distinction than in other generic groups. However, generic lines cannot be drawn sharply due to such groups as *Pachystelma*, *Labidostelma*, and *Macroscepis*. The only really unique feature of *Dictyanthus* is that the faucal callus, or annulus, of the corolla is digitate, as are the segments of the corona. I am prepared for vigorous opposition from those who are accustomed to think of *Dictyanthus* as exemplified by *D. Pavonii*. *M. altatensis* provides a very suggestive link with either *Pachystelma* or *Eumatelea*, according to one's viewpoint at a particular time.

VII. FISCHERIA DC. Cat. Hort. Monsp. 112. 1813.

I am maintaining *Fischeria* with misgivings, and only provisionally, since its affinities with the broad interpretation of

Matelea are unmistakable, as shown particularly in the pollinium structure and the mixed indument with interspersed bulbose, glandular hairs. In the Central American species the corona appears outstanding, but is scarcely different from that of *Eumatelea* § *Pseudobarbatae.* The anthers, also, show the inflated vesicular development mentioned in the key to genera. But in *F. viridis* Moldenke, recently discovered in Colombia, the corona is resolved into a more typical structure for *Matelea,* and the anthers are not vesicular. Should more species comparable to *F. viridis* appear in the rich South American flora, it is difficult to foresee what characters could be found to support the genus other than the crisped corolla lobes. Since *Fischeria* is not well represented in North America, the species there being quite easily distinguished, I am leaving the question of its validity until I am more familiar with the South American congeners.

VIII. GONOLOBUS Michx. Fl. Bor. Am. **1**: 119. 1803.

Vincetoxicum Walt. Fl. Carol. 13, 104. 1788, non Moench.
Fimbristemma Turcz. Bull. Soc. Nat. Mosc. **25**^{2}: 320. 1852.
Exolobus Fourn. in Mart. Fl. Bras. **6**^{4}: 318. 1885.
Trichostelma Baill. Hist. Pl. **10**: 287. 1891.
Lachnostoma of North American authors.

The complications concerning the use of *Gonolobus* Michx. and *Vincetoxicum* Walt., the "temporary" conservation of *Vincetoxicum* Moench. over the latter, and the typification of *Gonolobus* by *G. gonocarpos* (Walt.) Perry have been discussed in previous paragraphs (p. 213). It may be remembered that the original element of *Vincetoxicum* Walt. (or *Gonolobus,* through the rejection of the earlier name) consists of two species, *G. gonocarpos* (Walt.) Perry, the type, and *G. carolinensis* (Jacq.) Schultes *(V. acanthocarpos* Walt.). Until recently no question has been raised against the consideration of these two species as congeneric, and *Gonolobus* became the general catch-all for gonoloboid species without sufficiently striking innovations of the corona to prompt their

designation as separate genera. At about the opening of the present century, however, the earlier *Vincetoxicum* Walt. was revived by Dr. Britton and Miss Vail at the New York Botanical Garden. Transfers from *Gonolobus* were then in order, and few species of the complex have been described for that genus since. It seems rather severe that American botanists now will have to adjust themselves anew to the conservation of the dubiously valid *Vincetoxicum* Moench of Europe.

In 1933 (in Small, Man. Fl. 1076.) E. J. Alexander separated *G. gonocarpos* and *G. carolinensis* generically, founding the genus *Odontostephana* with the latter, together with other species from the southeastern United States. Alexander quite naturally used *Vincetoxicum* Walt. in place of *Gonolobus,* the judgment of the authorities at Kew not yet having been passed. The key characters used to separate *Vincetoxicum* from *Odontostephana* were taken from the coronas, whether "Crown disk-like or saucer shaped, obscurely if at all ridged," or "Crown cup-shaped or incurved at the tip, usually crested or appendaged on the inner side." In the descriptions of the two genera, attention was called also to the characters of the fruits, longitudinally winged in the former, and muricate in the latter, as observed by Walter in 1788. It is regrettable that *Odontostephana* is antedated by *Tetracustelma* Baill. if a narrow generic concept is adopted, and that a broad concept will submerge it in *Matelea* Aubl.

I have tried in vain to find characters of the corona which will separate *Gonolobus* and *Matelea,* but the structures of the anthers of the two genera appear to me as amply sufficient for distinction. The anthers of both vary considerably in size, position relative to the anther head, hyaline apical appendage, and nature of the marginal "wings." But in the species that I have assigned to *Gonolobus* the anther proper bears a more or less conspicuous, fleshy, usually laminate dorsal appendage which I never have found indicated to any degree in species assigned to *Matelea.* These dorsal appendages vary greatly from species to species, and although rather poorly developed as a rule in the temperate representatives, are very conspicu-

ous in the tropics. Typically, they are somewhat reniform in outline, but frequently deeply 2-lobed or entire, and rarely cleft into three divisions. The dorsal anther appendages are indicated in Alexander's figure for *Vincetoxicum* Walt. (loc. cit. 1933), although their significance is not mentioned, and a splendid illustration of them is provided by Baillon (Hist. Pl. **10**: 235. *fig.177.* 1891) for *G. erianthus.*

The dorsal anther appendages of *Gonolobus* have been overlooked in most species of North America, but they were made the chief foundation for the genus *Exolobus* by Fournier (cf. Mart. Fl. Bras. **6**[4]: *pl.94.* 1885), who designated them as "*corona superior.*" The species assigned to *Gonolobus* by Fournier all are of the element represented by *G. hirsutus* Michx. which I am relegating to *Matelea.* K. Schumann (in Engl. & Prantl, Nat. Pflanzenfam. **4**[2]: 298, 301–302. 1895) followed Fournier in the separation of *Gonolobus* and *Exolobus,* but appears to have been remarkably confused, for the dorsal anther appendages of my terminology are described as "inner corona" ("corona . . . innere an den A. befestigt, nach aussen strahlend, fleischig.") for the former, but for the latter simply as appendages of the anthers ("Stb. mit einem mittleren, fleischigen, nach aussen gerichteten Fortsatze. . ."). As I have explained previously (p. 199), flowers of *Gonolobus* as interpreted in this paper customarily have three structures which may be called "corona" if the terminology is loose: a corolline faucal annulus, frequently ciliate, a fleshy true corona borne at the base of the staminal column, and the dorsal appendages of the anthers proper. In his key to the Gonolobeae, Schumann (loc. cit. 298) places both *Gonolobus* and *Exolobus* under the division "II. Corona doppelt," and distinguishes them by "1. Äussere Corona kahl" and "2. Äussere Corona gewimpert," respectively, apparently referring to the corolline annulus.

In his descriptions of the two genera, however, Schumann reveals by his ambiguity how confused was his concept: "Corona ringförmig, einfach oder doppelt, die äussere zuweilen noch von einem häutigen Rande umgeben, so dass man fast 3

Coronen unterscheiden kann, oft ringförmig, der Blkr. angeheftet, kurz, gestutzt oder gelappt, zuweilen durch 5 Gewebeplatten mit dem Gynostegium verbunden; innere an den A. befestigt, nach aussen strahlend, fleischig'' *(Gonolobus,* p. 301); ''Corona doppelt: äussere in der Form eines sehr niedrigen, behaarten, aus den Blkr. vortretenden Ringes, die innere aus 5 freien Schuppen bestehend, welche der Röhre des Gynostegiums angeheftet sind. Stb. mit einem mittleren, fleischigen, nach aussen gerichteten Fortsatze und einem häutigen Mittelbandanhang'' *(Exolobus,* p.302). The *coup de grace* is given these verbal circumlocutions by a consideration of *fig. 92, N–T,* provided by Schumann (p.301) to illustrate *Gonolobus* and *Exolobus.* The floral structures are found to be equivalent in all important particulars, even to a ''gewimpert corona'' (ciliate corolline annulus) for *G. riparius.*

The extended quotations from Schumann should be sufficient to illustrate the ambiguity that results from treating the term ''corona'' in a complex sense. The dorsal anther appendages of *Gonolobus* are not equivalent to any structure found in *Matelea.* At one time during these studies, I suspected that they might represent the adnation to the anther of the inner ligules commonly accompanying the corona segments of the latter genus. This is shown to be erroneous, however, by the fact that these ligules almost invariably occur in *Gonolobus* in addition to the dorsal anther appendages, which apparently are more directly comparable to the vesicular tissue of the anthers of *Fischeria.*

I am not yet sufficiently informed to know positively what will result when this character is applied extensively to the South American gonoloboids, but wide observations indicate its validity. Supporting characters are found amongst the relatively few species of *Gonolobus* and *Matelea* for which fruit is known, the follicles of the former being longitudinally winged, infrequently quite smooth, and those of the latter muricate or infrequently smooth. The smooth condition would appear to be derived from both series. In *Matelea,* as has been explained previously, a peculiar indument of eglandular and

interspersed glandular hairs characteristically occurs; such an indument never is found in *Gonolobus*.

Amongst the North American species of *Gonolobus* with which I am familiar at present, the following divisions into subgenera appear both natural and convenient. As usual, I have illustrated them with necessary transfers.

KEY TO SUBGENERA

A. Corolla with widely spreading or reflexed lobes, with a more or less pronounced faucal annulus exterior to the true corona.
  B. Anthers only about half included beneath the broadly 5-gonal stigma head ..... 1. PTEROLOBUS
  BB. Anthers wholly (except the dorsal appendages) included beneath the saliently 5-gonal stigma head ..... 2. EUGONOLOBUS
AA. Corolla with erect or ascending lobes, without a faucal annulus ..... 3. PSEUDOLACHNOSTOMA

I should like to include *Trichostelma* Baill. in this key either as a subgenus or as a section under *Eugonolobus*, but the height of the corolline annulus appears to be far too variable.

SUBGENUS 1. PTEROLOBUS

GONOLOBUS **chiapensis** (Brandg.) Woodson, comb. nov.
Vincetoxicum chiapense Brandg. Univ. Cal. Publ. Bot. **6**: 190. 1915.

In addition to the preceding, *Pterolobus* includes such species as *G. niger* R.Br., *G. Salvinii* Hemsl., and *G. nemorosus* Dene. The name refers to the undulated wings of the follicles of the few species where I have observed them.

SUBGENUS 2. EUGONOLOBUS

GONOLOBUS **albomarginatus** (Pittier) Woodson, comb. nov.
Exolobus albomarginatus Pittier, Contr. U.S. Nat. Herb. **13**: 108. *fig.16*. 1910.

GONOLOBUS **aristolochiaefolius** (Brandg.) Woodson, comb. nov.
Fischeria aristolochiaefolia Brandg. Univ. Cal. Publ. Bot. **6**: 190. 1915.

GONOLOBUS **calycosus** (Donn.Sm.) Woodson, comb. nov.
Trichostelma ciliatum Baill. Hist. Pl. **10**: 288. 1891, non *G. ciliatus* Schltr.

Fimbristemma calycosa Donn.Sm. Bot. Gaz. **16**: 196. *pl. 16*. 1891.

GONOLOBUS **cteniophorus** (Blake) Woodson, comb. nov.
Vincetoxicum cteniophorum Blake, Contr. Gray Herb. 52: 84. 1917.
Vincetoxicum ? tortum Brandg. Univ. Cal. Publ. Bot. **10**: 414. 1924.
Vincetoxicum Lundellii Standl. Field Mus. Publ. Bot. **8**: 148. 1930.

GONOLOBUS **dasystephanus** (Blake) Woodson, comb. nov.
Vincetoxicum dasystephanum Blake, Contr. Gray Herb. 52: 84. 1917.

GONOLOBUS **Lasiostemma** (Hemsl.) Woodson, comb. nov.
Lachnostoma Lasiostemma Hemsl. Biol. Centr.-Am. Bot. **2**: 335. 1882.

GONOLOBUS **oblongifolius** (Donn.Sm.) Woodson, comb. nov.
Trichostelma oblongifolium Donn.Sm. Bot. Gaz. **48**: 296. 1909.

GONOLOBUS **stenanthus** (Standl.) Woodson, comb. nov.
Vincetoxicum stenanthum Standl. Field Mus. Publ. Bot. **4**: 255. 1929.

GONOLOBUS **stenosepalus** (Donn.Sm.) Woodson, comb. nov.
Fimbristemma stenosepala Donn.Sm. Bot. Gaz. **18**: 208. 1893.

SUBGENUS 3. PSEUDOLACHNOSTOMA

GONOLOBUS **arizonicus** (A.Gray) Woodson, comb. nov.
Lachnostoma arizonicum A.Gray, Proc. Amer. Acad. **20**: 296. 1885.

GONOLOBUS **gonoloboides** (Greenm.) Woodson, comb. nov.
Lachnostoma gonoloboides Greenm. Proc. Amer. Acad. **39**: 84. 1903.

IX. MARSDENIA R.Br. Mem. Wern. Soc. **1**: 28. 1809.
Nephradenia Dcne. in DC. Prodr. **8**: 604. 1844.
Ecliptostelma Brandg. Univ. Cal. Publ. Bot. **6**: 371. 1917.

I have been unable to find characters to distinguish *Nephradenia* except the erect, fruticose habit. *Ecliptostelma molle*

Brandg. (loc. cit. 1917) is identical with *Marsdenia Gilgiana* Rothe, which seems to be an extraordinarily variable species, even from the present meager representation, and which possibly should be merged with the very closely neighboring *M. mexicana* Dcne. For further generic synonyms, reference should be made to the monograph by Rothe (in Engl. Bot. Jahrb. **52**: 354–434. 1915). Following that standard work, new sections or subgenera probably will have to be erected to include both the following species, although I am deferring that action for the present.

Marsdenia **astephanoides** (A.Gray) Woodson, comb. nov.

Vincetoxicum astephanoides A.Gray, Proc. Amer. Acad. **22**: 435. 1887.

Cynanchum astephanoides (A.Gray) Standl. Contr. U.S. Nat. Herb. **23**: 1177. 1924.

Marsdenia **neriifolia** (Dcne.) Woodson, comb. nov.

Blepharodon neriifolium Dcne. in DC. Prodr. **8**: 604. 1844.

Nephradenia neriifolia (Dcne.) Benth. & Hook.; Hemsl. Biol. Centr. Amer. Bot. **2**: 336. 1882.

Nephradenia fruticosa Donn. Sm. Bot. Gaz. **16**: 196. 1891.

TWO NEW ASCLEPIADS FROM THE SOUTHWESTERN UNITED STATES

BASSETT MAGUIRE
Associate Professor of Botany, Utah State Agricultural College

ROBERT E. WOODSON, JR.
Assistant Professor in the Henry Shaw School of Botany of Washington University
Assistant Curator of the Herbarium, Missouri Botanical Garden

ASCLEPIAS **Ruthiae** Maguire, spec. nov. Herbae perennes; caudices multicipitales, caulibus nonnullis simplicibus suberectis 1.0–1.5 dm. altis crispo-pilosulis; folia opposita vel approximata late ovata apice aut acuminata aut abrupte mucronulata basi obtusa 2.2–4.5 cm. longa 1.5(1.0)–2.3 cm. lata, lamina sparse margine densius pilosula, petiolis 0.2–0.5 cm. longis minute pilosulis; inflorescentia aut terminalis aut lateralis umbelliformis pauciflora (2–7) sessilis, pedicellis filiformibus 1.5–2.5 cm. longis pilosulis; calycis lobi lanceolati acuti 0.2–0.3 cm. longi pilosuli violacei; corolla rotata pallide cano-violacea extus minute puberulo-papillata, lobis ovatis obtusis ca. 0.4 cm. longis patulis; staminum columna ca. 0.1 cm. alta viridula inter foliolas coronae saccata, antherae purpureae 0.15–0.23 cm. longae apicibus scariaceis obtusis integris; pollinia compresse elongato-pyriformia ca. 0.05 cm. longa; coronae foliolae saccatae ca. 0.2 cm. longae lobo dorso obtuso lobulis lateralibus obtusis longiore corniculo incluso roseo-purpureae; folliculi erecti falcate ovato-fusiformes 3–4(5) cm. longi dense pilosuli vel subglabrati.

UTAH: frequent, sandy soil, vic. water tank, Calf Springs Canyon, alt. 5000 ft., San Rafael Swell, 18 mi. southeast of Castle Dale, Emery Co., May 10, 1940, *Ruth & Bassett Maguire 18310* (Herb. Utah State Agricultural College, TYPE; Herb. Missouri Bot. Garden, ISOTYPE); Calf Spring Canyon, San Rafael Swell, June 5, 1940, *B. Maguire 18423* (Herb. Utah State Agr. Coll.; Herb. Missouri Bot. Gard.); same locality, June 7, 1940, *B. Maguire 18477* (Herb. Utah State Agr. Coll.;

Issued April 28, 1941.

Herb. Missouri Bot. Gard.); in the desert, 20 mi. south of Green River, June 8, 1939, *C. L. Porter 1799* (Rocky Mtn. Herb., Univ. Wyoming).

This is another member of the complex represented by *A. brachystephana, A. uncialis,* and *A. Cutleri* (cf. Woodson, Ann. Missouri Bot. Gard. **26**: 262. 1939), but is distinguished by its broadly ovate leaves and short lateral hood lobules. It

Fig. 1. *Asclepias Ruthiae* Maguire. Flower, pollinia, and hood in longitudinal section.

gives me much pleasure to dedicate it to my wife, Ruth R. Maguire, who was its discoverer and who so frequently is my helpful companion in the field.

ASCLEPIAS **Sperryi** Woodson, spec. nov. Herba suffrutescens ramosissima ca. 1.5 dm. alta habitu *A. macrotem* simulans; caules gracillimi suberecti compositi minutissime pilosuli vel glabrati, internodiis ca. 1.5–2.0 cm. longis; folia linearia 1–5 cm. longa ca. 0.05 cm. lata sessilia glabra; flores solitarii laterales, pedicellis ca. 1 cm. longis glabris; calycis lobi ovato-

lanceolati acuti 0.2–0.25 cm. longi papillati; corolla dilute viridula plus minusve purpureo-tincta, lobi ovato-elliptici acuti 0.5–0.6 cm. longi patuli; staminum columna vix manifesta, corona sessili; gynostegium ca. 0.3 cm. altum, antheris 0.1 cm. longis apicibus scariaceis inflexis, stigmate depresso ca. 0.25 cm. diam.; coronae foliolae habitu flosculo *Aristolochiae* similes gilvae vel dilute roseae dense papillatae parte basali patula ca. 0.2–0.3 cm. longa involuta margine alata corniculo umbonato incluso, parte superiori erecta laminata apice 3-

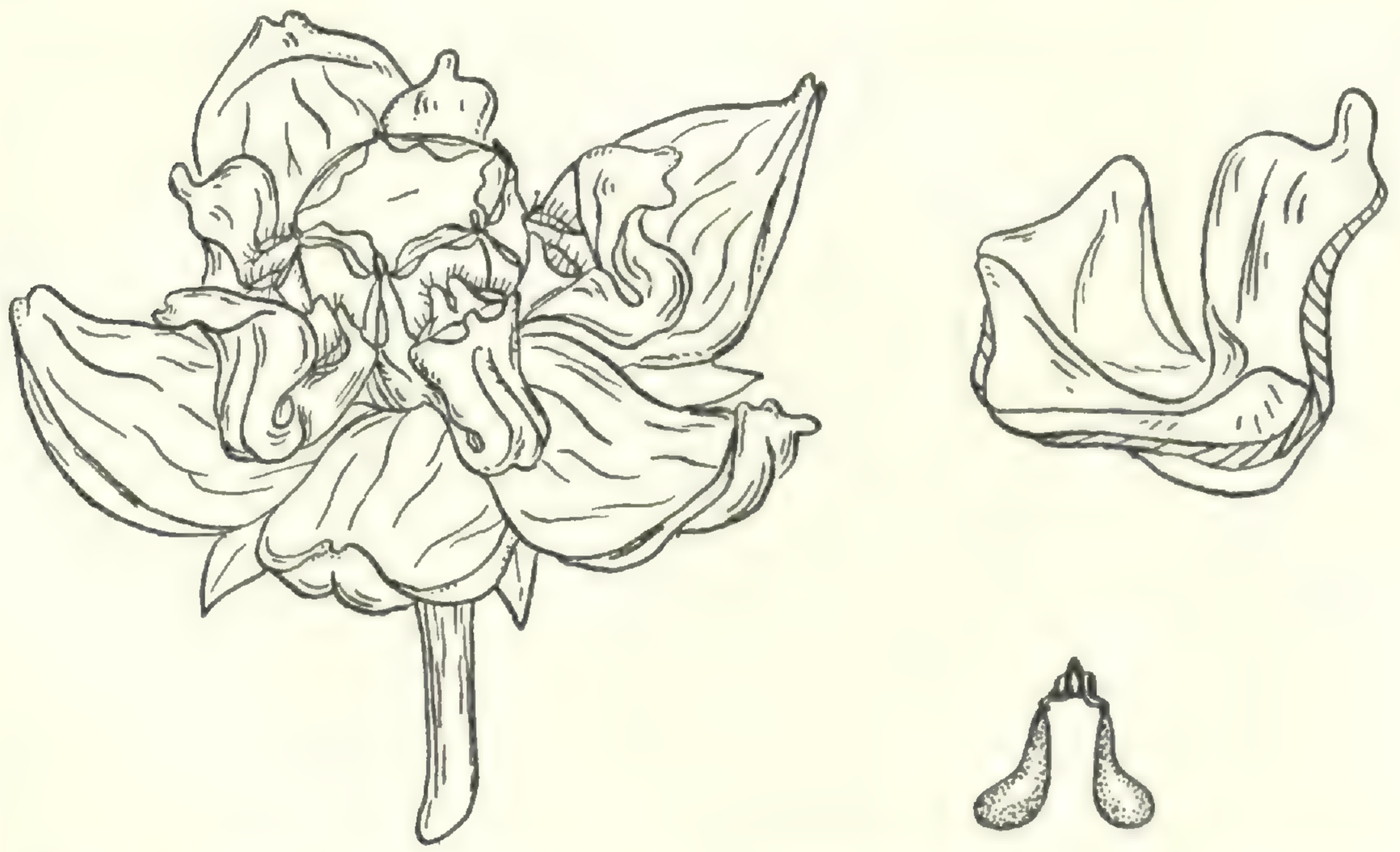


Fig. 2. *Asclepias Sperryi* Woodson. Flower, pollinia, and hood in longitudinal section.

lobulata; folliculi deflexi anguste fusiformes ca. 6 cm. longi 0.5 cm. crassi laeves glabri.

Texas: east of Nichols Ranch House, Glass Mountains, Brewster County, Aug. 1, 1938, *C. La Motte, O. E. Sperry, & B. H. Warnock T553* (Herb. Missouri Bot. Garden, type; Herb. Sperry, isotype); about 10 miles east of Alpine, Brewster County, May 21, 1936, *Sperry T301* (Herb. Missouri Bot. Garden; Herb. Sperry).

The superficial habit of this species is almost identical to that of *A. macrotis*, but the 1-flowered cymes and peculiar form

of the corona hoods are quite exceptional in the genus as represented in North America. It has been named for Professor Omer E. Sperry because of his activity in the botany of western Texas and in appreciation for his aid to my study of *Asclepias*.

Annals
of the
Missouri Botanical Garden

Vol. 28 SEPTEMBER, 1941 No. 3

A PRELIMINARY SURVEY OF THE GENUS TRIPSACUM

HUGH C. CUTLER

Research Fellow in the Henry Shaw School of Botany of Washington University

AND

EDGAR ANDERSON

Geneticist to the Missouri Botanical Garden
Engelmann Professor in the Henry Shaw School of Botany
of Washington University

When Mangelsdorf and Reeves[1] demonstrated in 1931 that *Zea* could be hybridized with *Tripsacum,* it became evident that a detailed monograph of the latter genus was of practical and theoretical importance. When in 1938[2] they advanced the hypothesis that *Tripsacum* had played an important role in the development of North American maize, such a monograph became a scientific necessity. The available evidence, taxonomic, genetic, and cytological, suggested that the relationships of the various entities in *Tripsacum* were very poorly understood and that they might be quite intricate; extensive field work, cytological examination of living material, and routine taxonomic techniques would all be necessary if an adequate understanding of the genus was to be reached. A comprehensive program was accordingly outlined, and two successive grants from the Penrose Fund of the American Philosophical Society

[1] Journ. Hered. **22**: 329–343.

[2] Proc. Nat. Acad. Sci. **24**: 303–312.

Issued September 20, 1941.

enabled Dr. Cutler to visit the chief eastern herbaria and to collect extensively in the United States, Mexico, and Guatemala in 1940 and 1941. We are also indebted to various other institutions and individuals for coöperation and support in the development of this program. For information, herbarium specimens, living plants, transportation, etc., acknowledgment should be made to G. T. Barrusta, P. C. Mangelsdorf, Mariano Pacheco, Ulises Rojas, H. B. Parks, and numerous others. We are under a very special obligation to J. H. Kempton, who not only supplied us with much pertinent information but even turned over to us his own unpublished notes on the genus.

It is now apparent that our original estimate was correct and that anything like a final judgment on the entities which make up the genus *Tripsacum* must await the collection and integration of evidence from several fields. We are therefore publishing this preliminary survey as a center about which the efforts of those interested in the problem may be coördinated. A collection of living plants is being assembled at the Missouri Botanical Garden, largely for cytological examination. We shall be grateful for plants or viable seeds from known localities or for chromosome counts made on plants of known derivation. We shall also appreciate herbarium specimens from localities other than those cited below. Plants, seeds, or specimens should be sent to Edgar Anderson, Missouri Botanical Garden, St. Louis, Missouri.

Tripsacum is unfortunately one of those genera which present special difficulties to the collectors and have consequently been rather neglected by them. Making an accurate and complete record of a *Tripsacum* plant on an ordinary herbarium sheet is like attempting to stable a camel in a dog kennel. By selecting portions of the plant and supplementing the specimen with pertinent information, an acceptable substitute for a complete specimen can be made, however. Where possible, such a record should include: (1) a terminal or lateral inflorescence (labelled as such since the terminal is usually more branched); (2) one or two successive internodes, with the sheaths, auricles, and lower portions of the leaf-blades attached; (3) a

complete leaf from one of the lowermost nodes, labelled as such (though neglected by many collectors this is particularly important since the species differ markedly in the degree to which the blade is constricted above the sheath on the lower leaves); (4) notes as to the height of the plants, number of nodes, and number of lateral inflorescences.

The available cytological evidence suggests that phylogenetic relationships within the genus may be quite complex. We are therefore deliberately postponing final judgment on many of the entities until chromosome counts can be made on a much larger scale and until our field studies are completed. Since we now know that the genus extends to South America it may be a matter of some years before the evidence is assembled. We have accordingly been conservative in proposing any new names, though under each species we have discussed briefly those variants which might ultimately receive recognition. The new species described from South America is advanced to this rank because it has previously been confused with a species to which in our opinion it bears no very close relationship.

Specimens are cited geographically according to states and alphabetically according to collectors under the states. The first time a collector's name appears his initials are given, if they be two or more; if not, the whole name where this is known. The following abbreviations have been used in referring to specimens in the various herbaria:

Ba—Bailey Hortorum, Cornell University.
F—Field Museum of Natural History.
Gray—Gray Herbarium, Harvard University.
Ha—Museum of Economic Botany, Harvard University.
MBG—Missouri Botanical Garden.
Mich—University of Michigan.
NY—New York Botanical Garden.
USDA—United States Department of Agriculture.
USNH—United States National Herbarium.
Wisc—University of Wisconsin.
Yale—Yale University.

Tripsacum L. Syst. Nat. ed. 10. 1261. 1759.

Digitaria Heist. ex Adans., Fam. Pl. **2**: 38, 550. 1763.

The genus has been a little-known one, and the variations within the species and the distribution have been left unstudied. A. S. Hitchcock[3] published a synopsis of *Tripsacum* in 1906, and in 1909 G. V. Nash[4] outlined the species for the 'North American Flora.' Since these two works appeared, many specimens have been collected, and although there are not yet enough to provide a firm basis for a complete revision of the genus, there are sufficient to indicate the problems which will be encountered.

1. **T. floridanum** Porter ex Vasey, Contrib. U. S. Nat. Herb. **3**: 6. 1892.

T. dactyloides var. *floridanum* Beal, Grasses N. Amer. **2**: 19. 1896.

This species is apparently distinct, and its delicate habit resembles that of *Manisuris cylindrica* more than that of any *Tripsacum* species.

The Texas collection is probably introduced from Florida as no collections between the points have been made.

FLORIDA: on road and glade at Crossman's, Dade Co., 9 Dec. 1903, *A. A. Eaton 530* (Gray, USNH); rocky soil recently burned, Gorruais, Dade Co., 25 Feb. 1905, *Eaton 1243* (Gray); Miami, June 1877, *A. P. Garber 77* (Gray, USNH TYPE); Miami, March 1903, *A. S. Hitchcock* (USNH); on coral rock, Homestead, 2 April 1906, *Hitchcock 686* (USNH); rocky soil near river, Miami, 4 April 1906, *Hitchcock 726* (USNH); between Florida City and Royal Palm State Park, 30 Oct. 1935, *H. L. Loomis* (MBG, USNH); moist ditch in tropical hammock, 3 miles west of South Miami, 30 Jan. 1933, *Hugh O'Neill 7610* (NY, USNH); Miami, 4–7 April 1898, *C. L. Pollard & G. N. Collins 272* (NY, USNH); pinelands near Nixon-Lewis Hammock, Dade Co., 15 Jan. 1916, *J. K. Small 7350* (Gray, MBG, NY, USNH); in everglades near the unfinished railroad grade between Cocoanut Grove and Cutler, 31 Oct.–4 Nov. 1903, *Small & J. J. Carter 597* (NY); pinelands, Homestead to Big Hammock Prairie, 15–17 Feb. 1911, *Small, Carter, G. K. Small 3433* (NY, USNH); in pinelands near the Homestead Trail, near Camp Longview, 13–16 May 1904, *Small & P. Wilson 1698* (NY); in pinelands, southern peninsular Florida, 6–7 May 1903, *Small & Wilson 1727* (NY); rocky pine forest, open places and along roadsides, Homestead, 15 Feb. 1935, *J. R. Swallen 5225* (USNH); Miami, 8 May 1904, *S. M. Tracy 9318* (Gray, MBG).

---

[3] Bot. Gaz. **41**: 297–298.

[4] N. Am. Fl. **17**: 79–81.

TABLE I

SPECIFIC CHARACTERS IN TRIPSACUM*

	Distribution	Height in meters	Leaf width in mm.	Shape of blade	Pubescence of sheath	Auricle	Number of branches in terminal inflorescence	Accessory male spikelets
T. floridanum	Florida	0.5–1	1–5	Not petiolate	Glabrous	Very indistinct	1 (2–3)	Sessile (subsessile)
T. dactyloides	Eastern and central U. S.	1–2	15–30 (40)	Not petiolate	Glabrous (scabrous)	Indistinct	1–2 (3–6)	Sessile (subsessile)
T. australe	S. America	?	10–40	Somewhat petiolate	Lanulose-tomentose within	Distinct to subdistinct	1–4	Sessile
T. lanceolatum	Arizona to Guatemala	0.5–2	10–30	Not petiolate	Sparsely hirsute	Very indistinct	1 (2–5)	Sessile to subsessile
T. fasciculatum	Mexico & Guatemala, widely cult.	1–3	30–80	Not petiolate	Glabrous	Indistinct	6 (1–12)	Pedicellate (sessile)
T. pilosum	Mexico to Guatemala	2–6	20–100	Not petiolate	Tuberculate-hispid	Distinct	15 (4–22)	Pedicellate (subsessile)
T. latifolium	Cent. Amer., West Indies, northern S. Amer.	1–4	20–80	Lower leaves petiolate	Glabrous (pilose)	Indistinct	2–3)	Sessile to pedicellate

* Parentheses signify variations from the usual condition.

TEXAS: damp sands, Beaumont, 24 April 1903, *J. Reverchon 4188* (Gray, MBG, USNH).

2. T. dactyloides (L.) L., Syst. Nat. ed. 10. 1261. 1759.
Coix dactyloides L., Sp. Pl. 972. 1753.
C. angulatus Mill., Gard. Dict. ed. 8. *Coix* no. 2. 1768.
Ischaemum glabrum Walt., Fl. Carol. 249. 1788.
T. monostachyum Willd., Sp. Pl. **4**: 202. 1805.
T. dactyloides var. *monostachyon* Eaton & Wright, N. Amer. Bot. ed. 8. 461. 1840.
T. compressum Fournier, Bull. Soc. Roy. Bot. Belg. **15**: 466. 1876.
T. dactyloides var. β *monostachyum* Fourn., Mex. Gram. 68. 1886.
Dactylodes angulatum Kuntze, Rev. Gen. Pl. **2**: 773. 1891.
T. dactyloides var. *monostachyum* Vasey, Contrib. U. S. Nat. Herb. **3**: 6. 1892.
Dactylodes Dactylodes (L.) Kuntze, Rev. Gen. Pl. **3**: 349. 1898.

This species is almost as variable as those to the south. There are at least five groups which can be distinguished although only one of these is distinct. (1) The specimens from along the Atlantic coast, which include the type, are less variable than any other group. The spike is usually solitary or binate, the staminate glumes stiff, bluntly tipped and the backs of them almost straight. (2) In Florida and adjacent Alabama and Georgia is found a wide-leaved and robust type with hairs at the ligule and on the inner side of the sheath and leaf adjacent. (3) On the prairies and plains and down to the Gulf coast of Texas and Louisiana is found a very variable form which, unlike all the other groups, with haploid chromosome numbers[5] of 36, has haploid numbers of 18. This group has staminate glumes which are more variable, more pilose and scabrous, and with the back greatly curved. In large colonies of this group it is usually possible to find several plants which have the upper staminate spikelet barely pedicellate. (4) From

[5] Mangelsdorf & Reeves. Texas Agr. Exp. Sta. Bull. 574. 1939.

Central Illinois there are three specimens (the only ones from that area) with sub-pedicellate staminate bracts and with glumes softer and occasionally tapering. More material of this form is particularly desirable.

CONNECTICUT: Guilford, 16 Aug. 1907, *A. I. Bartlett* (Yale); edge of salt marsh, Guilford, 19 Aug. 1906, *G. H. Bartlett* (Gray); Bridgeport, 1832, *H. C. Beardslee* (Yale); salt marsh at Pond Point, Milford, 27 July 1900, *C. H. Bissell 2033* (Yale, Gray); waste ground, Raton Point, Norwalk, 23 Aug. 1901, *Bissell 5389* (Yale); border of salt marsh, Guilford, 14 Aug. 1906 & 3 Sept. 1917, *Bissell* (Yale); in dry field by salt marsh, Stratford, 9 July 1912, *A. E. Blewitt 318* (Yale); Pond Point, Milford, 24 Aug. 1909, *H. S. Clark* (Yale); dry bank of Housatonic River, in colonies along coast, Stratford, 31 July 1893, *E. H. Eames* (Gray, Yale); south end, East Haven, 1882, *D. C. Eaton* (Yale); along shores and coves, East Lyme, Groton and Waterford, 1882–1889, *C. B. Graves* (Yale); brackish meadows, Branford, 3 Sept. 1902, *R. W. Woodward* (Gray, Yale).

NEW YORK: near garbage reduction plant, Staten Island, 16 July 1932, *J. A. Drushel 8309* (MBG).

PENNSYLVANIA: Safe Harbor, 2 Aug. 1882, *Small* (NY).

NEW JERSEY: sandy beach along Delaware River, near Elsinboro Point, 3 miles southwest of Salem, 31 Oct. 1933, *J. M. Fogg, 6280* (Gray); dike bordering tidal marsh, 1.5 miles southwest of Harrisonville, 29 Oct. 1934, *Fogg* (Gray); along stream, Woodbridge, 13 Sept. 1915, *L. H. Lighthipe* (MBG); Cape May, 4 Aug. 1909, *F. W. Pennell 2225* (USNH).

MARYLAND: Great Falls, 4 Sept. 1899, *C. R. Ball 68* (Gray); River View, 9 Aug. 1891, *F. Blanchard* (USNH); dry sandy soil, Salisbury, Sept. 1867, *W. M. Canby 173* (USNH); sandy beach, Millstone, 4 Aug. 1911, *Hitchcock 7886* (USNH); on rocks at Great Falls, 2 Sept. 1898, *T. Holm* (USNH); Mattawoman Creek, 3 Aug. 1914, *I. Tidestrom 7223* (Gray, MBG, USNH).

DELAWARE: near Wilmington, July 1866, *Canby* (Gray, Mich, MBG, Yale); Augustina Beach, 11 Aug. 1911, *J. R. Churchill* (Gray).

VIRGINIA: roadside, Arlington Farm, near Rosslyn, 13 Sept. 1933, *H. A. Allard 58* (Gray); Bedford Co., 15 Aug. 1871, *A. H. Curtiss 9848* (MBG); dry roadside bank, Munden, Princess Anne Co., 1 Aug. 1934, *M. L. Fernald & Bayard Long 3666* (Gray); rich alluvial woods and thickets back of sand beach of James River, Claremont Wharf, Surry Co., 13 June 1938, *Fernald & Long 8097* (Gray); swales, Munden, 3–19 Sept. 1905, *K. K. Mackenzie 1743* (Gray, NY); Portsmouth, 4 July 1897, *E. B. Noyes 3495* (Yale).

NORTH CAROLINA: Chapel Hill, May, *W. W. Ashe* (Yale); open moist low soil along Hitchcock Creek, Rockingham, Richmond Co., 25 Aug. 1936, *D. S. Correll 7124* (Gray); open bank of Lake Raleigh, Wake Co., 20 May 1938, *R. K. Godfrey 4014* (Gray, NY); sandy soil, marsh bordering Brice Creek, 2 miles southwest of James City, Craven Co., 11 July 1922, *L. F. & F. R. Randolph 868* (Gray); Asheville, 19 Aug. 1891, *A. B. Seymour 2* (Gray, MBG); ditch bank, Pullman Park, Raleigh, 27 June 1927, *K. M. Wiegand & W. E. Manning 120* (Gray).

SOUTH CAROLINA: damp soil, near Troy, McCormick Co., 8 May 1921, *John Davis*

2006 (MBG); in moist ditch along roadside, near the Clementia Tourist Camp, 14 miles south of Charleston, 8 Nov. 1929, *H. N. Moldenke 142* (NY); swale, south side of Santee River, north of Bonneau, Berkeley Co., 12 July 1927, *Wiegand & Manning 121* (Gray).

GEORGIA: Yellow River, Gwinnett Co., 27 July 1897, *H. Eggert* (MBG); sandy soil near Middle Oconee River, Clarke Co., alt. 620 ft., 29 June 1900, *R. M. Harper 99* (Gray, NY); field by Bobbin Mill Creek, Athens, 16 June 1934, *L. M. Perry 755* (NY); Yellow River near McGuire's Mill, Gwinnett Co., alt. 750 ft., 2 July 1895, *Small* (NY).

MISSISSIPPI: Grand Batture Island, 23 May 1911, *A. H. Howell 748* (USNH); Long Beach, 19 Aug. 1891, *J. F. Joor,* (MBG); near Starkville, 27 Sept. 1896, *T. H. Kearney 59* (Gray, USNH); Agricultural College, Oktibbeha Co., 11–17 Aug. 1896, *C. L. Pollard 1272* (Gray, MBG, NY, USNH); low ground, Milton, July 1931, *William Rhodes* (Gray); in ditches along roadside, Agricultural College, 17 July 1902, *P. L. Ricker 848* (USNH); Miller, De Soto Co., 12 July 1923, *L. E. Wehmeyer* (Mich).

FLORIDA: near Tallahassee, *N. K. Berg* (NY); hammock south of Miami, 8 Sept. 1907, *Agnes Chase 3903* (USNH); Homosassa, *Robert Combs 943* (Gray); along edge of saw grass and lakes in fertile hammock, not uncommon, Grasmere, Orange Co., 20 Sept. 1898, *Combs & C. F. Baker 1043* (USNH); large open prairies near small stream, uncommon or rare, Bradenton, Manatee Co., 1898, *Combs 1254* (USNH); low moist soil near Osprey, Sarasota Co., 9 July 1936, *Correll 5889* (Gray); open dry soil along edge of ditch, near Oviedo, Seminole Co., 8 Aug. 1936, *Correll 6355* (Gray); low thickets, Duval Co., June, *A. H. Curtiss 3626* (Gray, USNH), *3926* (NY); rich soil near Jacksonville, 13 June 1894, *Curtiss 4951* (NY); low black soil near St. Petersburg, 2 Oct. 1907, *Mrs. C. C. Deam 2827* (Gray); Alapattah, 24 Dec. 1903, *Eaton* (Gray); around pond, Fort Myers, Lee Co., July-Aug. 1900, *Hitchcock 534* (Gray, USNH); moist place by river, Miami, 29 March 1906, *Hitchcock* (USNH); Orange City, edge of marl pit, 28 May 1910, *S. C. Hood* (MBG); Apalachicola, 15 July 1895, *Kearney 105* (MBG); salt marshes, Fort George Island, Duval Co., 9 June 1896, *Lighthipe 462* (NY); 8–12 ft. high, in flatwoods near L. Hancock, growing in clumps of palmetto west of Winter Haven, Polk Co., 6 June 1931, *J. B. McFarlin 5689* (USNH); in dry sandy field, Hollywood, Broward Co., 9 Feb. 1930, *Moldenke 583* (MBG, NY); in everglades, along Tamiami Trail, 25 miles west of Miami, Dade Co., 26 Dec. 1927, *Moldenke 3743* (NY); clay soil, vicinity of Eustis Lake, Lake Co., 1–15 April 1894, *G. V. Nash 374* (Gray, MBG, NY, USNH); edge of a cypress swamp, 4–7 ft. tall, Lake Harris, near Ocklawaha River, 5 July 1895, *Nash 2140* (NY); Lake City, Columbia Co., 11–19 July 1895, *Nash 2207* (Gray, USNH); Little River, 26 March 1923 *D. C. Peattie 1915* (USNH); Lake City, 29 June 1894. *P. H. Rolfs 806* (MBG, USNH); 1842, *F. Rugel 438* (MBG, USNH); hammock, Cutler, 15 Nov. 1906, *Small & Carter* (NY); Ft. Myers, Lee Co., 1 June 1916, *J. P. Standley 215* (Gray, MBG, USNH); moist place among pines and scrub palmetto, Titusville, 29 May–3 June 1926, *Swallen 212* (MBG, USNH); edge of old cultivated field, Marianna, 25–29 June 1926, *Swallen 492* (USNH); Long Key, 25 May 1901, *S. M. Tracy 7775* (Gray, USNH); edge of salt marsh, Ormond, 8 Aug. 1896, *H. J. Webber 472* (USNH).

ALABAMA: Auburn, 12 June 1897, *G. W. Carver 48* (USNH); in a swale, near

Selma, 29 June 1895, *Kearney 10* (Gray, MBG, NY, USNH); low rich places, Mobile, 1 June 1883, *Charles Mohr 603* (USNH); *Alex. Winchell 236* (USNH).

LOUISIANA: U. S. Rice Experiment Station, 1 mile west of Crowley, Acadia Parish, 21 May 1940, *H. C. Cutler 3156* (Ba, F, MBG, NY, Ha, USDA); 1 mile east of Vinton, alt. 60 ft., 3 May 1941, *Cutler 4813* (MBG); in salty swamps, Pointe a la Hache P. O., 4 July 1885, *A. B. Langlois* (USNH); prairie, Welsh, Jefferson Davis Parish, 17 May 1915, *E. J. Palmer 7652* (NY); large clump in swamp, Cameron Co., 11–13 June 1931, *Swallen 1891* (USNH); east bank of lower Bayou Little Caillou, 27 miles below Houma, near Cocodrie, 8 June 1913, *E. C. Wurzlow* (USNH).

MICHIGAN: along railroad tracks, Utica, 11 Aug. 1922, *O. A. Farwell 6297* (Mich, Gray, USNH).

INDIANA: common along a ditch through a cultivated field about 5 miles east of Lincoln City, Spencer Co., 10 Oct. 1931, *C. C. Deam 51560* (USNH).

TENNESSEE: Nashville, *A. Gattinger* (Gray, USNH); along the French Broad River between Paint Rock and Del Rio, Cocke Co., 10 Sept. 1897, *Kearney 938* (NY, USNH); low places, Spring City, July 1929, *Rhodes* (Gray).

ILLINOIS: wet prairies about Salem, July 1860, *M. S. Bebb* (Gray, Yale); Kickapoo Prairie, near Washington, wet ground, June 1835, *George Engelman* (MBG); Spoon River bottom, Fulton Co., 6 June 1842, *O. B. Mean* (USNH); Hancock, 1842, *Mean* (Wisc).

IOWA: infrequent in wet places, Decatur Co., 14 July 1897, *T. J. & M. F. L. Fitzpatrick* (NY).

MISSOURI: uncommon, rocky river banks, Greene Co., 4 Sept. 1892, *B. F. Bush 430* (NY); Montier, 30 June 1894, *Bush 877* (MBG); on Skinker's Wege, St. Louis, 29 June 1875, *Eggert* (MBG); Springfield, 1897, *S. A. Hoover* (Gray); Jerome, 6 June 1914, *J. H. Kellogg* (MBG); St. Clair, Franklin Co., 12 June 1928, *Kellogg 2103* (MBG); Washington, Franklin Co., 25 June 1888, *L. H. Pammel* (MBG); low ground northeast of Springfield, 21 Aug. 1912, *P. C. Standley 9155* (USNH); low woods along Black River, ¼ mile west of Hendrickson, Butler Co., 30 June 1936, *Julian Steyermark 11321* (MBG); sandy alluvium along Eleven Point River, 1½ mile north of McCormack Hollow, Oregon Co., 27 July 1936, *Steyermark 12322* (MBG); lower wooded slopes bordering field along King's River, southeast of Allen Ford, in Barry Co., 22 June 1937, *Steyermark 22577* (MBG); open limestone slopes along Indian Creek near Holy Cliff, 3½ miles northeast of Topaz, Douglas Co., 19 July 1937, *Steyermark 23366* (MBG).

ARKANSAS: low wet fields, Monticello, Drew Co., *Delzie Demaree 13690* (NY); wet places, Miller Co., 23 July 1896, *Eggert 155* (USNH); Monticello, 24 July 1881, *G. W. Letterman* (USNH); open field adjacent to station, Stuttgart, 30 July 1932, *D. M. Moore 32805* (NY).

KANSAS: along railroad, 5 miles northwest of Lawrence, Douglas Co., 18 June 1938, *Edgar Anderson* (MBG); Florence, 28–30 July 1903, *David Griffiths 5045* (USNH); sandy roadside, 2 miles west of St. George, Riley Co., 3 June 1908, *Hitchcock 2527* (USNH); 2–3 ft. high, low prairie, Manhattan, 24 June 1913, *Hitchcock 10420* (USNH); wet places, Riley Co., 20 June 1895, *J. B. Norton 580* (Gray); schoolhouse hill & town reservoir, Pleasanton, Linn Co., 19 June 1929, *P. A. Rydberg & Ralph Imler 85* (NY); Big Spring, 3 or 4 miles south of Bilby's Lakes, 16 July 1929, *Rydberg & Imler 1072* (NY); high prairie, Lawrence, Aug. 1892, *W. C. Stevens 62* (USNH).

OKLAHOMA: Cimarron Valley, Cherokee Outlet, 1891, *M. A. Carleton 225* (USNH); in the Indian Terr., chiefly on the False Washita, between Fort Cobb & Fort Arbuckle, 1868, *Ed. Palmer 422* (Yale); grassy valley near Fairvalley, Woods Co., 28 May 1913, *G. W. Stevens 753* (Gray, USNH); in large gravelly bar in Spring River, near Ottawa, Ottawa Co., 29 Aug. 1913, *Stevens 2510* (Gray); grassy sandy valley near Guthrie, Logan Co., 14 June 1914, *Stevens 3284* (Gray).

TEXAS: Leon Springs, Bexar Co., 19 May 1911, *Mr. & Mrs. J. Clemens 21* (MBG, USNH); Soil Conservation Service Nursery, San Antonio, 23 May 1940, *Cutler 3158* (MBG, Ha); Soil Conservation Service Nursery, from seed secured from Bellville, Texas, 23 May 1940, *Cutler 3159, 3160, 3161, 3164, 3165* (MBG, Ha); Parita Creek, Bexar-Wilson Co. line crossing, alt. 700 ft., locality of Mangelsdorf & Reeves "San Antonio" *Tripsacum*, 23 May 1940, *Cutler 3169* (MBG); Kemah, alt. 20 ft., 3 July 1926, *G. L. Fisher 267* (USNH); 6 miles west of Raywood, Liberty Co., alt. 60 ft., 6 May 1941, *Cutler 4815* (MBG); between Ft. Bend and Harris Cos., 11 miles southwest of Houston, alt. 60 ft., 6 May 1941, *Cutler 4816* (MBG); Houston, 11 July 1915, *Fisher 1711* (USNH); wet ground, Houston, 20 April 1872, *Elihu Hall 844* (Gray, NY, USNH); roadside, Waxahachie, 19 May 1936, *H. E. Hazard* (Gray); Harvester, 24 April 1906, *Hitchcock 1198* (USNH); edge of woods near river, New Braunfels, 20 June 1910, *Hitchcock 5240* (USNH); bank of stream, San Antonio, 24 June 1910, *Hitchcock 5255* (USNH); 1888, *G. C. Nealley* (Gray, NY, USNH); rocky creek banks, Austin, Travis Co., 12 May 1918, *E. J. Palmer 13659* (USNH); rich damp lands, Dallas, May 1879, *Reverchon 1156* (USNH); dry sands, Lindale, 15 May 1902, *Reverchon 2804* (NY); Boerne Road at Bexar Co. line, 31 May 1931, *W. A. Silveus 128* (USNH); open places, Brackenridge Park, San Antonio, 4 Oct. 1933, *Sister Mary C. Metz* (NY); in water, Knickerbocker Ranch, Dove Creek, Tom Green Co., May 1880, *Frank Tweedy* (Gray, Yale).

(5) The fifth group is distinct and occupies a separate area on the western edge of the range of the species. All the specimens seen have been from west of the Pecos River. It is probable that there are intergrades but the group is decidedly different from specimens from central and eastern Texas.

2a. T. dactyloides var. **occidentale**, n. var.[6]

Similar to the species but the staminate glumes more than 9 mm. long, softer, and tapering to an acute tip.

TEXAS: shaded ledges at base of bluff, Little Aguja Canyon, Davis Mts., Jeff Davis Co., alt. 1520 m., 15 June 1931, *J. A. Moore & Julian Steyermark 3092* (Gray, Mich, MBG TYPE, NY, USNH); Chisos Mts., 5 Aug. 1931, *C. H. Mueller 7891* (MBG); rocky partially shaded ground, along streams, near Alpine, Brewster Co., 8 June 1926, *Palmer 30584a* (MBG); rocky banks of creek, in deep canyon, Oak Canyon, Chisos Mts., Brewster Co., 24 May 1928, *Palmer 24159* (Gray, MBG,

[6] **T. dactyloides** var. **occidentale**, var. nov., speciei simile sed glumis stamineis plusquam 9 mm. longis, mollioribus et mucronatis ad apicem.

NY); rocky plains, partially shaded situations amongst syenite boulders, Davis Mts., Jeff Davis Co., 4 Oct. 1926, *E. J. Palmer 31923* (MBG, NY, USNH); Ft. Davis, 1881, *V. Havard* (USNH).

3. **Tripsacum australe**, n. sp.[7]

T. dactyloides subsp. *hispidum* Hitchcock, Bot. Gaz. **41**: 295. 1906, in part.

Plant slender to robust, nodes usually enlarged; leaves 1–4 cm. wide, somewhat petiolate, blades smooth, usually glabrous, sheath with distinct to semi-distinct auricles, outer surface glabrous below, lanulose-tomentose above, at maturity barely clasping the culm, culm lightly to heavily lanulose-tomentose; inflorescence of 1–4, rarely more, spikes, staminate spikelets sessile.

This species is readily distinguished from *T. dactyloides* by the lanulose tomentum investing portions of the culm and sheath, the tendency of the leaves to become petiolate, and its range. From *T. latifolium* it is distinguished with difficulty in the northern part of its range but the specimens may be determined by the presence of the tomentum, and (on the herbarium specimens, at least) the less petiolate leaves.

The type of tomentum is considerably different from that found in the specimens of *T. lanceolatum* with which the Morong specimen was grouped to form a subspecies of *T. dactyloides*. In the South American plants *(T. australe)* the tomentum is soft and felted while in those of Mexico the hairs are distinct, thicker and harsh.

SOUTH AMERICA:

BOLIVIA: among shrubs, Coroico, Nor-Yungas, alt. 1560 m., 25 Dec. 1923, *Hitchcock 22721* (Gray, USNH); marshy edges of forest, Ixiamus, Amazon Basin, alt. 1000 ft., 22 Dec. 1921, *O. E. White 2324* (NY, USNH TYPE).

BRAZIL: *Burchell 9066* (Gray, USNH); in savannas among shrubs, Pará-Marajo Island, Carocara River, June 1914, *Andre Goeldi 87* (USNH); Morrinho do Lyra, Linha Telegr., Matto Grosso, May 1918, *T. G. Kuhlmann 1833* (USNH); *L. Riedel 1279* (Gray, MBG).

---

[7] **Tripsacum australe**, sp. nov. Planta gracilis vel robusta; nodis plerumque tumidis; foliis 1–4 cm. latis, aliquid petiolatis, laminis levibus plerumque glabris; vaginis cum auriculis plerumque distinctis, superficie exteriore basi glabra, apice lanuloso-tomentosa; culmo lanuloso-tomentoso; inflorescentia plerumque 1–4 spicis, spiculis stamineis sessilibus.

BRITISH GUIANA: Kanuku Mts., behind Parika, Rupunini District, Jan. 1934, *J. G. Meyers 4342* (USNH).

COLOMBIA: coarse herb, up to 6 ft., open hillside, Dept. Santander, upper Rio Lebrija valley, northwest of Bucaramanga, alt. 400-700 m., Eastern Cordillera, 29 Dec. 1926, *E. P. Killip & A. C. Smith 16279* (Gray, NY, USNH); 1760–1808, *J. C. Mutis 5489* (USNH); 5–6 feet tall, local and rather rare on hillsides in sheltered places, generally on the border of forest below 2500 ft., near Masinga, Santa Marta, alt. 400 ft., 27 Oct. 1898, *H. H. Smith 2745 (= 119)* (Gray, MBG, NY, USNH).

ECUADOR: partly shaded slope, large bunches, 4–6 ft., between Huigra and Naranjapata, Prov. Chimborazo, alt. 600–1200 m., 17 July 1923, *Hitchcock 20643* (Gray, NY, USNH).

PARAGUAY: Cerro de Tobatí, 14 Jan. 1903, *K. Fiebrig 746* (Gray); Uferwaldrand feucht, bei Gestein, zwischen Rio Apa und Rio Aquidaban, 1908–1909, *Fiebrig 4613* (Gray); in regione versus superioris fluminis Apa, 1901–2, *E. Hassler 7901* (Gray); in altaplanitie et declivibus, Sierra de Amambay, Dec. 1907, *Hassler 9953* (USNH); Central Paraguay, 1888–1890, *Thomas Morong 675* (MBG, NY, USNH); on the Paraná, 26°–24° S. lat., April 1883, *D. Parodi 53* (NY).

VENEZUELA: on slopes, forms large tufts, ascent from Motatan Bridge to Carvajal, near Valera, Trujillo, *H. Pittier 10768* (Gray, NY, USNH); near Escuque, Trujilla, in savannas on road to Valera, 11 Jan. 1929, *Pittier 13151* (USNH).

4. Tripsacum lanceolatum Rupr. ex Fourn., Mex. Gram. 68. 1886.

T. lanceolatum Rupr. in Benth., Pl. Hartweg. 347. 1857, *nomen nudum.*

T. acutiflorum Fourn., Bull. Soc. Roy. Bot. Belg. **15**: 466. 1876, *nomen nudum.*

T. Lemmoni Vasey, Contrib. U. S. Nat. Herb. **3**: 6. 1892.

T. dactyloides var. *Lemmoni* (Vasey) Beal, Grasses N. Amer. **2**: 19. 1896.

T. dactyloides var. *angustifolium* Scribn. in Urbina, Cat. Pl. Mex. 376. 1897.

T. dactyloides subsp. *hispidum* Hitchc., Bot. Gaz. **41**: 295. 1906, in part.

While Nash[8] (1909) accepted the description by Fournier in 1876 as constituting valid publication, no real distinctions between species were made in Fournier's article and it therefore cannot be accepted. Fournier's later description is based on specimens and is detailed enough to distinguish between the species then known.

[8] N. Am. Fl. **17**: 81.

It is possible to separate the specimens of *T. lanceolatum* into three general groups but these have some intergrades, and until further collections are made and more entire plant specimens observed, it will be futile to attempt to delimit these groups.

The type specimen is from Aguas Calientes in Central Mexico, and the group from the central plateau is characterized by a large amount of anthocyanin coloring, narrow leaves, and solitary or paired spikes in the inflorescence. Closest to this group are those specimens found on the west slopes of Mexico, which have broader leaves, solitary to ternate inflorescence spikes, and are the most robust.

From these two groups it is easy to separate those specimens from southern Arizona which formerly went under the name of *T. Lemmoni.* These are characterized by an inflorescence lacking anthocyanin and much divided, with as many as nine spikes, usually pedicellate upper spikelet, and narrow leaves. With present material, this group may be readily separated by the gap between its representatives and those of the other groups. The gap must not, however, be interpreted as a real absence of the plant but as an absence of collections from northern Mexico.

T. Lemmoni is probably distinct enough to be considered a good species, but until the extent of the variations within the species *T. lanceolatum* has been determined and until collections have been made at more points in northern Mexico it will be better to consider *T. lanceolatum* as a variable species with *T. Lemmoni* as one of several groups within it.

There are several specimens, as that of Brandegee from El Taste, Baja California, 1 Nov. 1902, which do not fit well into any of the three groups but are well within the species as interpreted herein. There is some resemblance to *T. dactyloides* in the northeastern Mexican specimens, for example, in *Wynd & Mueller 536,* with larger glumes and wider leaves.

ARIZONA: ½ mile north up lateral canyon, 8 miles down Sonoita Creek from Patagonia, Santa Cruz Co., 28 April 1941, *H. C. Cutler & J. D. Freeman* (MBG); Mule Mts., about 5000 ft., 20 Sept. 1929, *G. J. Harrison & T. H. Kearney 6101*

(Gray, USNH); grown in Washington, D. C. greenhouse by J. H. Kempton, from seeds secured in southern Arizona, probably the Mule Mts., by *Kearney*. U.S.D.A. No. T29-29, picked Oct. 1934 (MBG, USNH); on a high peak with southern slope, near moist rocks, Huachuca Mts., 21 Sept. 1882, *J. G. Lemmon 2932* (Gray, USNH type of *T. Lemmoni)*; near Patagonia, 23 Feb. 1930, *H. F. Loomis 6409* (USDA, USNH).

MEXICO:

AGUAS CALIENTES: Aguas Calientes, 1839, *Theodor Hartweg 252* (NY cotype, complete specimen, USNH, fragments from the Steudel and the Trinius herbaria, cotypes, and Boissier Herb. TYPE).

BAJA CALIFORNIA: El Taste, 13 Sept. 1893, *T. S. Brandegee 4* (NY); Sierra de San Francisquito, 29 Sept. 1899, *Brandegee 6* (USNH); El Taste, 1 Nov. 1902, *Brandegee* (USNH).

CHIHUAHUA: infrequently scattered, occurring as small groups, 2 or 3 m. high, pine oak country; Sierra Canelo, Rio Mayo, 29 Aug. 1936, *H. S. Gentry 2496* (Gray, MBG); in large clumps in arroyo bed by running water, Sierra Charuco, Rio Mayo, 1 Oct. 1936, *Gentry 2914* (Gray); rocky ravine, 8000 ft., Sanchez, 12 Oct. 1910, *Hitchcock 7702* (USNH); Rio Bonito "hot country," 25 Aug. 1936, *Harde Le Sueur Mex-093* (USNH).

COAHUILA: moist stream side, Hacienda Piedra Blanca, Canyon de Sentenela, Sierra del Carmen, Villa Acuña, 6 July 1936, *F. L. Wynd & C. H. Mueller 536* (Gray, MBG, NY, USNH).

COLIMA: large bunches on rocky cliff by seashore, Manzanillo, 20 Sept. 1910, *Hitchcock, Amer. Gr. Nat. Herb. No. 230* (Gray, MBG, NY, USNH); rocky hillside, alt. 1500 ft., Alzada, 21 Sept. 1910, *Hitchcock 7082* (Mich, NY, USNH), *7083* (USNH).

DURANGO: rocky hill, Iron Mt., Durango, alt. 6200 ft., 6–8 Oct. 1910, *Hitchcock 7630* (USNH), *7648* (NY, USNH); La Bajada, Tamazula, 300–600 m., Nov. 1921, *J. G. Ortega 4334* (USNH); city of Durango and vicinity, April–Nov. 1896, *Ed. Palmer 537* (Gray, MBG, NY, USNH).

GUERRERO: 33 km. south of Chilpancingo on Mexico-Acapulco road, alt. 1360 m., 24 Sept. 1940, *Cutler 3918* (Ba, Ha, F, MBG, USDA); on rocks of cliff, alt. 1500 ft., Balsas, 9 Sept. 1910, *Hitchcock 9816* (USNH).

JALISCO: Arenal, 9 Oct. 1923, *Collins & Kempton 79* (USNH); Barranca de Oblatos, Guadalajara, 12 Oct. 1923, *Collins & Kempton 81, 85, 88* (USNH); 0.5 km. north of Tonilita, alt. 700 m., 9 Oct. 1940, *Cutler 4011* (MBG, Ha), *4017* (MBG), *4018* (Ba, Ha, F, MBG, USDA); Platanar, on railroad 53 km. north of Colima, alt. 1000 m., 10 Oct. 1940, *Cutler 4087* (MBG, Ha); walls of barranca, 1 km. northeast of Ciudad Guzman (Zapotlan), alt. 1520 m., 10 Oct. 1940, *Cutler 4088* (MBG), along creek, same locality and date, *4104* (MBG), alt. 1600 m., *4105* (Ba, F, Ha, MBG, NY, USDA); side of Barranca de Oblatos, Guadalajara, alt. 5000–6000 ft., 27–28 Sept. 1910, *Hitchcock 7358* (USNH); La Barranca, Guadalajara, 21 Nov. 1930, *M. E. Jones 27628* (MBG, NY, USNH); Barranca de Oblatos, Guadalajara, 15 Oct. 1921, *Kempton & Collins* (USNH Nos. 1064495–1064497); Hacienda San Diego, Cocula, 21 Oct. 1921, *Kempton & Collins* (USNH); mts. near Guadalajara, 16 Dec. 1889, *Pringle 2610* (USNH); road between Juejuquilla & Mesquitec, 25 Aug. 1897, *Rose 3570* (Gray, USNH).

MEXICO (including DISTRITO FEDERAL): Barranca de Dolores, Lomas de Chapultepec, Aug. 1940, *G. T. Barrusta* (MBG); pedregal near Mexico, 26 June, *M. Bourgeau 444* (Gray); Tlalpam, alt. 7480 ft., 3 Aug. 1924, *Fisher* (MBG); San Angel, alt. 7350 ft., 2 Aug. 1926, *Fisher 53* (USNH); Temascaltepec, alt. 1750 m., 30 Aug. 1932, *G. B. Hinton 1444* (Gray); hill, Tejupilco, 1340 m., Temascaltepec, 4 Sept. 1932, *Hinton 1600* (Gray); copse, edge of field, Tacubaya, 27–30 July 1910, *Hitchcock 5909* (USNH); Mexico City, Oct. 1896, *E. W. D. Holway 8* (USNH); Pedregal de San Angel, Sept. 1927, *E. Lyonnet 61* (Gray, MBG, NY, USNH); rare on volcanic soils, pedregal, Tlalpam, alt. 2300 m., 30 Oct. 1928, *M. St. Pierre 828* (USNH); Tacubaya, *J. G. Schaffner 41* (USNH, fragment from Paris Herb.).

MICHOACAN: near Cerro de las Nalgas, alt. 1900 m., vicinity of Morelia, 9 Sept. 1909, *Bro. G. Arsène 2572* (USNH); Cerro de las Nalgas, alt. 800 m., 9 Sept. 1909, *Arsène* (USNH); near La Huerta, 1950 m., vicinity of Morelia, 1 Sept. 1910, *Arsène 5576* (MBG, NY, USNH); cascade near Loma de La Huerta, alt. 1950 m., vicinity of Morelia, 1 Sept. 1910, *Arsène 7006* (USNH).

MORELOS: small clumps, rocky cliffs, alt. 4500 ft., Cuernavaca, 10–11 Sept. 1910, *Hitchcock 6840* (Mich, USNH); Valle de Tepeite, 16 Sept. 1938, *Lyonnet 2421* (USNH); Teposteco, 22 Sept. 1938, *Lyonnet 2552* (USNH); Xochitepec, 24 Sept. 1938, *Lyonnet 2645* (USNH); Barranca de San Anton, near Cuernavaca, 28 Oct. 1904, *Seler 4348* (USNH).

NAYARIT: Los Fresnos, Tepic, 2 Oct. 1923, *Collins & Kempton T35* (USNH); Cerro del Cruz, Tepic, 1 Oct. 1923, *Kempton & Collins T17* (USNH).

NUEVO LEON: Diente Canyon, Sierra Madre, Monterrey, 29 July 1933, *C. H. & M. T. Mueller 368* (Gray, USNH); in moist places, dense woods bordering stream, Canyon Marisio Abajo, Rancho Las Adjuntas, Municipio de Villa Santiago, 27 June 1935, *Mueller 2069* (Mich, Gray, USNH).

OAXACA: rocky cliff, Oaxaca, 5000 ft., 12–13 Aug. 1910, *Hitchcock 6160* (USNH); Villa Alta, Aug. 1842, *F. M. Liebmann 547* (USNH).

PUEBLA: source au dessus de la finca Guadalupe, alt. 2121 m., 20 Nov. 1906, *Arsène 73* (USNH); Mayorazgo, sur l'Atoyac, alt. 2120 m., vic. Puebla, 7 July 1907, *Arsène 1328* (MBG, USNH); near Hacienda Batan, Barranca de la Alseseca, alt. 2120 m., vicinity of Puebla, 13 June 1907, *Arsène 1472* (MBG, USNH); entre les haciendas Santa Barbara y Cristo, sur l'Alseseca, alt. 2150 m., vic. Puebla, 27 June 1907, *Arsène* (MBG, USNH); Acatzinco, Distrito de Tepeaca, vic. Puebla, alt. 2110 m., July 1907, *Arsène 2266* (MBG, USNH); Mayorazgo, alt. 2120 m., vic. Puebla, 4 July 1907, *Arsène 10106* (USNH); El Riego, July 1905, *C. A. Purpus 1227* (MBG).

SAN LUIS POTOSI: limestone ridges, San Jose Pass, 15 Aug. 1890, *Pringle 3447* (USNH); rocky hills, Las Canoas, 14 Aug. 1891, *Pringle 3811* (Gray, MBG, NY, USNH TYPE of *T. dactyloides* subsp. *hispidum*); Bargre, Aug. 1911, *C. A. Purpus 5433* (USNH).

SONORA: small infrequent colonies, 2–3 m. high, oak hill slope, Quirocoba, Rio Fuerte, 22 Oct. 1936, *Gentry 2953* (USNH); Guadalupe Canyon, 27 Aug. 1893, *E. C. Merron 2035* (USNH); Santa Rosa Canyon, near Bavispe, northeast Sonora, 19 July 1938, *S. S. White 601* (Gray); small valley in granitic hills, 14 miles north of Babiacora on road to Cumpas, 22 Sept. 1934, *I. L. Wiggins 7392* (Mich, USNH).

TAMAULIPAS: Sierra de San Carlos, vicinity of San Jose, alt. 3040 ft., 13 July 1930, *H. H. Bartlett 10310* (NY, USNH).

YUCATAN: edge of old field, Chichen Itza, 7–13 July 1932, *Swallen 2482* (USNH).

GUATEMALA: Lake Retana, north of Jutiapa, 18 Oct. 1935, *Kempton & Wilson Popenoe* (MBG, USNH); San Pedro, alt. 5600 ft., 28 Oct. 1935, *Kempton & Popenoe* (MBG, USNH); below San Pedro, alt. 4600 ft., 29 Oct. 1935, *Kempton & Popenoe* (MBG, USNH); hills above San Lucas, 4500 ft., 9 Nov. 1935, *Kempton & Popenoe* (MBG, USNH).

5. Tripsacum fasciculatum Trin. ex Ascherson, Verh. bot. Ver. Prov. Brandenb. **17**: 79. 1875.

T. fasciculatum Trin. ex Steud., Nomencl. Bot. **2**: 712. 1841, *nomen nudum;* Gram. **1**: 363. 1855, *nomen nudum;* ex Rupr., Bull. Acad. Roy. Brux. **9**: 243. 1842, *nomen nudum.*

T. laxum Nash, N. Amer. Fl. **17**: 81. 1909.

This species has a rather wide range of variation but is easily distinguished in most cases by the smooth sheaths, the wide and not petiolate leaves, and the robust habit.

Specimens from cultivation vary considerably, and this may be due to a more favorable environment. In central Guatemala *T. fasciculatum* is cut for forage, probably from native stands. This species apparently has a high degree of sterility. Herbarium specimens of it or of *T. pilosum* never reveal the shiny seeds which in *T. dactyloides* are indicative of a well-developed endosperm. Nearly a thousand seeds were collected in Mexico and Guatemala but all those examined had undeveloped embryos, and when planted have so far failed to germinate. The amount of variation in time of flowering and size and number of parts of large colonies in both Mexico and Guatemala, however, suggest that the members of a colony are not all of the same clone.

In northern Guatemala and in western Mexico no intergrades have been found between *T. pilosum* and *T. fasciculatum*, although both of these occur in the region. They have never been reported from the same spot but their habitat requirements are similar.

Specimens with solitary terminal spikes are infrequent, and although such plants usually have narrower leaves than those with a much branched inflorescence, the leaves are still wider than those of *T. lanceolatum* and the plant more robust.

MEXICO:

COLIMA: rocky, grassy hillside, 1500 ft., Alzada, 21 Sept. 1910, *Hitchcock 7103* (Mich).

GUERRERO: 36 km. south of Chilpancingo, alt. 1360 m., 24 Sept. 1940, *Cutler 3915–3917, 3921* (Ba, F, Ha, MBG).

VERA CRUZ: Mirador, Aug. 1841, *Liebmann 549* (MBG, USNH); [Fortin], Zacuapan, 1917, *Purpus 8027* (Gray, MBG, NY, USNH); Hacienda de la Laguna, Barrio de Tinxedo, 1836, *C. T. Schiede 947* (TYPE, not seen).

GUATEMALA: Jardin de Don Mariano Pacheco, plants from Coban, Alta Verapaz, 8 Nov. 1941, *Cutler 4301* (Ha, MBG); field at 19.5 km. on Guatemala-Barberena road, alt. 6500 ft., 9 Nov. 1940, *Cutler 4306* (Ba, F, Ha, Mich, MBG, NY, USDA, USNH); same locality, 17 Nov. 1940, *Cutler 4324* (MBG); below San Pedro, alt. 4600 ft., 29 Oct. 1935, *Kempton & Popenoe* (MBG, USNH); *J. J. Rodriguez*, received 21 June 1916, grown in quarantine house, U. S. D. A. No. 42967 (USNH); edge of pine forest, Quirigua, Dept. Izabal, alt. 75–225 m., 15–31 May 1922, *Standley 24256* (USNH).

SALVADOR: San Salvador, 1922, *Salvador Calderón 1332* (Gray, NY, MBG, USNH); seed from *C. Deusen*, grown in greenhouse, Washington, D.C., 14 March 1924 (USNH); cultivated as forage, 21 Nov. 1916, *Carlos Renson 1, 2* (USNH); cultivated, vicinity of San Salvador, 650–850 m., 30 March–24 April 1922, *Standley 22631, 23637* (Gray, MBG, USNH).

PANAMA: cultivated for forage, Coclé, alt. 600 m., *Paul Allen 2252* (MBG).

6. T. pilosum Scrib. & Merr., U. S. Dept. Agric. Div. Agrost. Bull. 24: 6. 1901.

We have never seen this species or *T. fasciculatum* growing without having found *T. lanceolatum* near by. *T. pilosum* is more selective in its habitat, and in localities on the west slope of Mexico it will be found in more protected sites while *T. lanceolatum* will extend beyond the margins of the best localities. Thus, *T. pilosum* is usually restricted to damp spots in open woods, along the railroads and on the slopes of deep canyons, but *T. lanceolatum* will grow in these places and in addition will fringe the upper rim of the canyon and encroach upon the dry plains and hillsides.

There is a local distinction between these two species. *T. pilosum* is known as *maiscillo*, *T. lanceolatum* as *sacaton*, a general term for coarse grasses. The irritating hairs of *T. pilosum* have been noted by Kempton (MS.), and we found that the hand which grasped the basal sheaths of this species during a day of collecting would remain swollen and sore for several days.

This species differs from *T. lanceolatum* in its more robust growth habit, the densely tuberculate-hispid leaf sheaths, and the large numbers of spikes in the inflorescence. From *T. fasciculatum* it differs mainly in the hispid character of the leaf sheaths but the pedicels of *T. fasciculatum* are, in addition, usually shorter and thicker, the number of spikes smaller, and the plant less robust.

MEXICO:

COLIMA: open grassy ground among rocks, steep slope of ravine, Alzada, 21 Sept. 1910, *Hitchcock 7088*, or *Amer. Gr. Nat. Herb. No. 231* (Gray, MBG, NY, USNH).

DURANGO: Sierra Madre, alt. 5200 ft., 15 Aug. 1897, *J. N. Rose 3513* (USNH).

GUANAJUATO: garden of college, Guanajuato, 1901, *Alfredo Dugès* (Gray).

JALISCO: frequent widely separated clumps, 3.7 m. high, 0.5 & 5.0 km. north of Tonilita, alt. 1000 m., 9 Oct. 1940, *H. C. Cutler 4013* (MBG) & *4019* (Ba, F, Ha, MBG, USDA); frequent on walls of barranca 1 km. northeast of Ciudad Guzman (Zapotlan), alt. 1520 m., 19 Oct. 1940, *Cutler 4079, 4080, 4081, 4082* (MBG); same data, *4089* (Ha, MBG); same locality, 22 Oct. 1940, *Cutler 4090* (Ha, MBG); same data, *4091, 4092* (MBG); 3 m. tall, frequent along creek, northeast edge of Ciudad Guzman, alt. 1520 m., 22 Oct. 1940, *Cutler 4110* (Ha, MBG), *4111* (Ba, Ha, MGB, USDA); inflorescence collections from single clones 1 km. northeast of Ciudad Guzman, 22 Oct. 1940, *Cutler 4117, 4118* (MBG); side of Barranca Oblato, Guadalajara, alt. 5000–6000 ft., 27–28 Sept. 1910, *Hitchcock 7343, 7361, 7366* (USNH); La Barranca, Guadalajara, 19 Nov. 1930, *M. E. Jones 27629* (MBG); Barranca de Oblatos, Guadalajara, 15 Oct. 1921, *J. H. Kempton & G. N. Collins* (USNH Nos. 1064498, 1064499, 1064500, 1064503); garden, Etzatlan, 22 Oct. 1921, *Kempton & Collins* (USNH); Etzatlan, 23 Oct. 1921, *Kempton & Collins* (USNH); Los Teosintes, Ampaso, 23 Oct. 1921, *Kempton & Collins* (USNH); Ciudad Guzman, 27 Oct. 1921, *Kempton & Collins* (USNH); Arupara, 23 Oct. 1921, *Kempton & Collins* (USNH); Rio Blanco, June–Sept. 1886, *Ed. Palmer* (Gray, NY, Yale, USNH); hills near Guadalajara, 29 June 1889, *Pringle 2611* (USNH); canyons near Guadalajara, 3 Dec. 1889, *Pringle 2623* (USNH); road between Coatlan and Bolaños, 7–9 Sept. 1897, *Rose 2841* (Gray, USNH TYPE); *Rose & Robert Hay 6278* (USNH).

MICHOACAN: Cerro San Miguel, near Morelia, 10 Feb. 1912, *Arsène 9938* (USNH).

NAYARIT: Los Fresnos, Tepic, 2 Oct. 1923, *Collins & Kempton T34* (USNH); Jala, near Ahuacatlan, 7 Oct. 1923, *Collins & Kempton 80* (USNH); Cerro del Cruz, Tepic, 1 Oct. 1923, *Kempton & Collins* (USNH Nos. 1646091–1646093, 1646115–1646118).

OAXACA: Cerro San Felipe, alt. 1800 m., Distrito del Centro, 12 Aug. 1906, *C. Conzatti 1615* (USNH); Las Sedas, Distrito de Etla, alt. 2000 m., 29 Aug. 1909, *Conzatti 2523* (USNH); Cañada San Juan, Zimatlan, alt. 1925 m., 2 Oct. 1931, *Conzatti 4638* (Mich).

SAN LUIS POTOSI: limestone ledges, Tinanul, 24 July 1891, *Pringle 3993* (USNH); hills, Las Palmas, 24 July 1891, *Pringle 3993* (USNH).

GUATEMALA: Kalkberge, Quien Santo, Huehuetenango, 23 Aug. 1896, *E. Seler 2723* (Gray, USNH).

7. Tripsacum latifolium Hitchc., Bot. Gaz. **41**: 294. 1906.

It is only with difficulty that some of the herbarium specimens of this species may be distinguished. The petiolate character of the large lower leaves seems to be distinctive in this species, but most collectors take only the upper portions of the plant with leaves small enough to put on a herbarium sheet. The rarely collected complete plant series, as *Bartlett 11888*, serve to connect the extremes of the species found in the West Indies, as *Ekman 16226*, and the terminal collections with the type.

West Indian plants are very slender, small, with solitary terminal inflorescences, usually deeply colored with purple. They must, however, be considered as a variant of the species not worthy of distinction at this time.

BRITISH HONDURAS: 10 feet tall, edge of ravine, Mountain Pine Ridge, El Cayo District, 1 March 1931, *H. H. Bartlett 11888* (Mich, NY); near river bank, El Cayo District, Vaca, 4 March 1938, *P. H. Gentle 2298* (USNH).

GUATEMALA: 18 ft. high, near Secanquim, trail to Cahabon, 25 Nov. 1904, *G. P. Goll 44* (USNH); Sierra del Mico, between Los Amates & Izabal, alt. about 750 ft., 23 Feb. 1907, *W. A. Kellerman 6242* (USNH); between San Marcos and San Andreas, alt. 4500 ft., 2 Nov. 1935, *Kempton & Popenoe* (MBG, USNH); La Libertad, Petén District, 18 April 1933, *C. L. Lundell 2836* (Mich); vic. Secanquim, Alta Verapaz, alt. 550 m., 6 May 1905, *H. Pittier 261* (USNH); Cubilquitz, Dept. Alta Verapaz, alt. 350 m., Jan. 1902, *H. von Tuerckheim 8333* (USNH TYPE); 12–15 ft. tall, rich upland soil, hillside north of Quirigua, 2 March 1932, *Weatherwax 90 (1703)* (USNH).

HONDURAS: Tela, 14 Feb. 1931, *Collins & Kempton* (USNH); plants 6–15 ft. high, forming dense colonies, in open swamp, Uluita Station, 24 Jan. 1928, *Standley 54941* (USNH); San Pedro Sula, Dept. Santa Barbara, alt. 1600 ft., 1887, *Carl Thieme 5595b* (USNH); rich soil along river, 6 km. west of Siguatepeque, 1200 m. alt., *T. G. Yuncker, R. F. Dawson, H. R. Youse, 6391* (Mich, MBG, USNH).

PANAMA: cultivated, 1931, *Armour Expedition* (MBG, USNH).

WEST INDIES:

HAITI: open slopes, vicinity of Mission, Fonds Varettes, alt. about 1000 m. and above, 17 April–4 May 1920, *E. C. Leonard 3945* (Gray, USNH); dry ravine northeast of West Indies Co. Plantation, vicinity of St. Michel de l'Atalye, Dept. du Nord, 350 m., 18 Nov. 1925, *Leonard 7157* (USNH).

SANTO DOMINGO: Cordillera Septentrional, Prov. Santiago, Santiago, Cuesta de Piedras, alt. 200 m., 23 Nov. 1930, *E. L. Ekman 16229* (USNH); vast colonies, steep slope near the top, R. D. Cordillera Central, Prov. Santo Domingo, Villa Altagracia, Loma Marian Chicle, 800 m., 6 Jan. 1930, *Ekman 14253* (USNH); prope La Salinas in via do Los Cerarcos, 700 m. alt., Prov. Barahona, Sept. 1911, *Padre Miguel Fuertes 1424* (NY).

TRINIDAD: La Brea, 9 March 1915, *W. E. Broadway 4982* (USNH).

EXCLUDED SPECIES

The taxonomy of *Rottboellia* and *Manisuris* is in such confusion that, for the most part, we have not been able to go beyond the 'Index Kewensis'.

Mistakes in copying generic names (Index Kew. Suppl. **2**: 187. 1904; and Kunth, Enum. Pl: **1**: 467, 602. 1833), mistakes in identification (Schlecht. & Cham., Linnaea **6**: 40. 1831), adoption and listing of herbarium label names (Urbina, Cat. Pl. Mex. 376. 1897), and other errors have introduced names which must be included in this list of excluded species or under synonymy. It is unfortunate that many of these mistakes were published in the 'Index Kewensis.'

Tripsacum aegilopoides Kunth, Enum. Pl. **1**: 467, 602. 1833 = **Rottboellia hirsuta** Vahl, Symb. Bot. **1**: 11. 1790.

T. aristatum Rasp., Ann. Sci. Nat. I, **5**: 306. 1825 = **Ischaemum aristatum** L. Sp. Pl. 1049. 1753.

T. avenacea Scribn. & Merr. (U. S. Dept. Agric. Div. Agrost. Bull. 24: 23. 1901) acc. to Index Kew. Suppl. **2**: 187. 1904 = **Tristachya avenacea.**

T. ciliare Rasp., Ann. Sci. Nat. I, **5**: 306. 1825 = **Elionurus tripsacoides** HBK. Nov. Gen. et Sp. **1**: 192. *t. 62.* 1816.

T. compressum Rasp., Ann. Sci. Nat. I, **5**: 306. 1825 = **Hemarthria compressa** R. Br., Prodr. 207. 1810.

T. cylindricum Michx., Fl. Bor. Amer. **1**: 60. 1803 = **Manisuris cylindrica** Kuntze, Rev. Gen. Pl. **2**: 779. 1891.

T. distachyum Poir., Encyc. **8**: 114. 1808 = **Ischaemum rugosum** Salisb., Ic. Stirp. Rar. **1**: *t. 1.* 1791.

T. distichum Rasp., Ann. Sci. Nat. I, **5**: 306. 1825 = **Ischaemum rugosum** Salisb., Ic. Stirp. Rar. **1**: *t. 1.* 1791.

T. fasciculatum Rasp., Ann. Sci. Nat. I, **5**: 306. 1825 = **Chloris radiata** Sw., Prod. Veg. Ind. Occ. 26. 1788.

T. giganteum Rasp., Ann. Sci. Nat. I, **5**: 306. 1825 = **Anthistiria gigantea** Cav., Ic. **5**: 35. 1799.

T. granulare Rasp., Ann. Sci. Nat. I, **5**: 306. 1825 = **Hackelochloa granularis** Kuntze, Rev. Gen. Pl. **2**: 776. 1891.

T. hermaphroditum L. Syst. Nat. ed. 10. 1261. 1759 = **Anthephora hermaphrodita** Kuntze, Rev. Gen. Pl. **2**: 759. 1891.

T. hirsutum Rasp., Ann. Sci. Nat. I, **5**: 306. 1825 = **Rottboellia hirsuta** Vahl, Symb. Bot. **1**: 11. 1790.

T. laxa Scribn. & Merr. (U. S. Dept. Agric. Div. Agrost. Bull. 24: 23. 1901) acc. to Index Kew. Suppl. **2**: 187. 1904 = **Tristachya laxa.**

T. mucronatum Rasp., Ann. Sci. Nat. I, **5**: 306. 1825 = **Trachys mucronata** Pers. Syn. **1**: 85. 1805.

T. muticum Rasp., Ann. Sci. Nat. I, **5**: 306. 1825 = **Ischaemum muticum** L. Sp. Pl. 1049. 1753.

T. myuros Rasp., Ann. Sci. Nat. I, **5**: 306. 1825 = **Rottboellia Myurus** Benth., Journ. Linn. Soc. **19**: 68. 1881.

T. paniceum Rasp., Ann. Sci. Nat. I, **5**: 306. 1825 = **Pogonatherum saccharoideum** Beauv., Agrost. 176. *t. 11. f. 7.* 1812.

T. pubescens Lichenst. ex Nees, Fl. Afr. Austr. **1**: 74. 1841 = **Anthephora pubescens** Nees, Fl. Afr. Austr. **1**: 74. 1841.

T. pubescens Willd. ex Steud., Nom. Bot. ed. 2, **1**: 317. 1841 = **Cenchrus pubescens** Steud., Nom. Bot. ed. 2, **1**: 317. 1841.

T. semiteres Wallich, Cat. no. 8628. 1828 = **Polytoca semiteres** Benth. in Benth. & Hook. f., Gen. Pl. **3**: 1113. 1883.

MISCELLANEOUS NEW ASCLEPIADACEAE AND APOCYNACEAE FROM TROPICAL AMERICA

ROBERT E. WOODSON, JR.

Assistant Curator of the Herbarium, Missouri Botanical Garden
Assistant Professor in the Henry Shaw School of Botany of Washington University

APOCYNACEAE

RAUWOLFIA **sarapiquensis** Woodson, spec. nov. Arbor ca. 15 m. alta omnino glabra; ramulis crassiusculis post exsiccationem plus minusve angulatis cortice luteo-brunneo tectis, internodiis 3–4 cm. longis. Folia ternata inaequalia in axillis glandulosa, petiolis 1.5–2.5 cm. longis; laminis obovato-ellipticis abrupte acuminatis basi sensim attenuatis 14–20 cm. longis 5.0–6.5 cm. latis coriaceis, venis secondariis subhorizontalibus. Inflorescentia foliis dimidia brevior subterminalis ternata, pedunculo primario ca. 6 cm. longo deinde repetite 4- vel 3-natim composito. Flores albi; pedicello 0.4 cm. longo; calycis laciniis ovato-subreniformibus rotundatis 0.25–0.3 cm. longis; corollae tubo cylindrico 0.5 cm. longo ca. 0.15 cm. diametro, lobis oblongis rotundatis adscendentibus 0.4 cm. longis ca. 0.15 cm. latis; staminibus prope fauces affixis 0.1 cm. longis apiculatis; ovario syncarpo 0.15 cm. longo nectarium annulare minute crenatum ca. bis superante; stylo gracili 0.15 cm. longo, stigmate capitato 0.05 cm. longo dense papillato apice minute 2–lobato. Baccae ignotae.—COSTA RICA: Vara Blanca de Sarapiquí, north slope of Central Cordillera, between Poás and Barba volcanoes, alt. 1460 m., Febr., 1938, *A. F. Skutch 3556* (U. S. Nat. Herb., TYPE).

Somewhat intermediate between the sections Grandiflorae and Andinae, and not obviously related to any species known to occur in Central America.

Quadricasaea Woodson, gen. nov. (Apocynaceae-Plumeroideae-Tabernaemontaninae). Calyx inaequaliter 5-partitus intus multiglanduligerus. Ovarii carpellae liberae ovariis

Issued September 20, 1941.

numerosis multiseriatim positis nectario annulato valde adnato in stylo gracili gradatim productae stigmate subumbraculiformi obscure 2-lobato. Corolla salverformis limbi lobis 5 sinistrorse obtengentibus. Antherae sessiles anguste sagittatae omnino fertiles.—Frutices volubiles. Folia opposita eglandulosa. Inflorescentia bostrycino-racemosa aut lateralis aut terminalis. Genus in honorem cl. J. Cuatrecasatis dedicatur. Species typica prima sequitur.

QUADRICASAEA **inaequilateralis** Woodson, spec. nov. Frutex volubilis sat magnus. Folia opposita breviter petiolata late elliptica apice breviter acuminata basi inaequilateraliter obtusa 20–30 cm. longa 7.5–9.0 cm. lata firme membranacea glabra, petiolis 0.4 cm. longis. Inflorescentia lateralis bostrycino-racemosa, pedunculo ca. 2 cm. longo, pedicellis ca. 1 cm. longis, omnino glabra; calycis lobis valde inaequalibus ovatis vel late ovato-oblongis apice rotundatis 0.7–1.0 cm. longis ut dicitur subpetalaceis albidis glabris; corollae flavae extus glabrae tubo ca. 3.25 cm. longo basi ca. 0.45 cm. diam. paulo infra medium usque 0.2 cm. diam. constricto ibique staminigero deinde gradatim ampliato, faucibus ca. 0.4–0.45 cm. diam., lobis oblique elliptico-oblongis obtusis ca. 2.5 cm. longis patulis; antheris angustissime sagittatis acuminatis basi acutissime 2-lobatis sessilibus glabris ca. 0.6 cm. longis; ovariis ovoideis glabris ca. 0.3 cm. longis in stylo gracili gradatim productis, nectario annulato adnato ca. 0.1 cm. alto, stigmate ca. 0.1 cm. longo. Fructus ignoti.—COLOMBIA: COMISARIA DEL CAQUETA: Florencia, entre matorrales residuales de monte, alt. 400 m., March 29, 1940, *J. Cuatrecasas 8814* (U. S. Nat. Herb., TYPE).

QUADRICASAEA **caquetensis** Woodson, spec. nov. Frutex volubilis sat magnus. Folia opposita breviter petiolata elliptico-oblonga apice anguste acuminata basi aequilateraliter acuteque cuneata cum petiolo 14–20 cm. longa 2.5–5.5 cm. lata firme membranacea glabra. Inflorescentia subterminalis bostrycino-racemosa pauciflora, pedunculo ca. 0.5 cm. longo, pedicellis ca. 1 cm. longis, omnino glabra; calycis lobis valde inaequalibus ovatis vel late ovato-oblongis apice rotundatis

0.7–1.2 cm. longis ut videntur subpetalaceis albidis glabris; corollae flavae extus glabrae in alabastro sat maturo tubo ca. 3 cm. longo.—COLOMBIA: COMISARIA DEL CAQUETA: Cordillera Oriental, vertiente oriental, Sucre, bosques entre 1000 y 1300 m. alt., April 4, 1940, *J. Cuatrecasas 9062* (U. S. Nat. Herb., TYPE).

Quadricasaea is particularly outstanding because it is the only genus of the American Tabernaemontaninae with the habit of a liana, all other genera being trees or shrubs. The structure of the corolla, inflated at base and throat and constricted at the insertion of the stamens, is also noteworthy. Although it appears somewhat dangerous, upon short acquaintance, to describe two species of such close affinity from the same general region, the leaves of *Q. inaequilateralis* and *Q. caquetensis* are so dissimilar that it is quite logical to do so. The inflorescences are probably specific as well.

MANDEVILLA **jasminiflora** Woodson, spec. nov. Frutex ca. 3 m. altus; ramulis crassiusculis teretibus valde lenticellatis glabris. Folia opposita petiolata oblongo-elliptica acuminata basi obtusa 3.5–8.0 cm. longa 1.0–1.25 cm. lata subcoriacea margine post exsiccationem revoluta supra glabra nervo medio in longitudinem sparse glanduligero subtus inconspicue pilosula, petiolo ca. 0.8–1.5 cm. longo glabro. Inflorescentia lateralis racemosa pluriflora, pedunculo ca. 3.0–3.5 cm. longo parce pilosulo, pedicellis tenuibus ca. 0.7 cm. longis pilosulis, bracteis scariaceis minimis; calycis laciniis ovato- lanceolatis acutis extus ca. 0.2 cm. longis pilosulis, squamellis oppositis multifissis; corollae flavae campanulatae extus glabrae tubo 0.3 cm. longo basi ca. 0.1 cm. diam. faucibus ca. 0.3 cm. diam. intus pilosulo, lobis fere erectis ovato-ellipticis acutis ca. 0.35 cm. longis; antheris 0.2 cm. longis basi obscure 2-lobatis glabris; ovariis ovoideis ca. 1 cm. longis glabris, nectariis 5 ovariis fere aequilongis, stigmate umbraculiformi longe apiculato ca. 0.2 cm. longo. Folliculi ignoti.—COLOMBIA: CALDAS: Quindio, alt. 2900 m., Febr., 1937, *E. Dryander 2145* (U. S. Nat. Herb., TYPE). Although clearly in the subgenus *Exothostemon*, this species is quite unlike any other known at present, both because of its relatively large, shrubby habit and because of the small

flowers of unusual shape which recall the Mexican *M. Syrinx* Woodson, a liana of the subgenus *Eumandevilla.*

Mandevilla **nerioides** Woodson, spec. nov. Frutex ut dicitur altitudine ignotus; ramulis crassiusculis tenuiter alatis glabris cortice rubro-brunneis. Folia opposita brevissime petiolata lineari-lanceolata acuminata basi obscure cordata cum petiolo 4–7 cm. longa 0.3–0.6 cm. lata subcoriacea glabra nervo medio supra in longitudinem pauciglanduligero. Inflorescentia terminalis subspicata pauciflora, pedunculo 2.0–4.5 cm. longo glabro, pedicellis ca. 0.2 cm. longis, bracteis minutissimis; calycis laciniis ovatis anguste obtusis ca. 0.25 cm. longis glabris, squamellis oppositis multifissis; corollae speciosae albido-roseae extus glabrae tubo proprio 1.5 cm. longo basi ca. 0.1 cm. diam., faucibus conico-campanulatis 2 cm. longis, ostio ca. 1.25 cm. diam., lobis oblique obovatis 2 cm. longis patulis; antheris 0.45 cm. longis ellipticis basi brevissime auriculatis glabris; ovariis ovoideis ca. 0.1 cm. longis, nectariis 5 ovaria ca. dimidia aequantibus, stigmate umbraculiformi brevissime apiculato ca. 0.1 cm. longo. Folliculi ignoti.—Colombia: Rio Guaviare: San José del Guaviare, terrenos graniticos, 270 m. alt., Nov. 12, 1939, *J. Cuatrecasas 7674* (U. S. Nat. Herb., type). Closely related to *M. lancifolia* Woods., but differing in its stouter habit, larger flowers, and broader leaves with cordate bases.

Malouetia **Cuatrecasatis** Woodson, spec. nov. Arbuscula altitudine ignota; ramulis crassiusculis glabris maturitate cortice griseo-brunneo bene lenticellato. Folia opposita petiolata oblongo-elliptica apice obtuse acuminata basi late cuneata 4–6 cm. longa 1–2 cm. lata omnino glabra supra nitidula subtus opaca in axillis nervi medii rare foveata, petiolo 0.4–0.5 cm. longo. Umbellae laterales 1– vel pauci-florae, pedicellis 1.2 cm. longis glabris; calycis laciniis ovatis rotundatis vel obtusis 0.2–0.25 cm. longis subfoliaceis glabris vel indistincte papillaltis, squamellis solitariis alternatis; corollae salverformis albidae tubo ca. 1 cm. longo basi ca. 0.1 cm. diam. sub medio usque 0.25 cm. diam. dilatato deinde gradatim contracto,

faucibus abrupte campanulatis ca. 0.2 cm. diam., ostio conspicue calloso-annulato, lobis elliptico-ovatis obtusis 1.2 cm. longis extus papillatis intus dense minuteque puberulis; antheris valde exsertis ca. 0.2 cm. longis dense puberulo-papillatis; ovariis ca. 0.15 cm. longis puberulo-papillatis, nectariis concrescentibus ovaria subaequantibus. Folliculi ignoti.—COLOMBIA: VAUPÉS: Mitu, bosque, 200 m. alt., Oct. 20, 1939, *J. Cuatrecasas 7285* (U. S. Nat. Herb., TYPE). Closely allied to *M. lata* Mgf. of the lower Amazon Valley, but differing in the blunt calyx lobes of heavier texture and in the longer, narrower corolla tube.

ASCLEPIADACEAE

CYNANCHUM (METALEPIS) **subpaniculatum** Woodson, spec. nov. Frutex volubilis; ramulis crassiusculis glabris. Folia longe petiolata late ovato-cordata sinu aperto apice abrupte acuteque subcaudato-acuminata 14–16 cm. longa 10–12 cm. lata glabra firme membranacea nervo medio supra basi glanduligero, petiolo 9–10 cm. longo glabro. Inflorescentia axillaris foliis ca. duplo longior bostrycine spicato-paniculata mutiflora, pedunculis sparse pilosulis; calycis laciniis oblongo-ellipticis acutis 0.35 cm. longis extus minute papillatis; corollae rotatae lobis ovato-ellipticis acuminatis 0.4–0.45 cm. longis extus papillatis intus papillatis prope apicem conspicue barbatis plus minusve retro-revolutis; gynostegio breviter stipitato apice ca. 0.5 cm. diam. stigmate umbonato; polliniis leviter reniformibus ca. 0.09 cm. longis, caudiculis gracilibus ca. 0.1 cm. longis, corpusculo minuto; corona pentagulo-patelliformi ca. 0.5 cm. diam. intus dense papillata, segmentis late emarginatis. Folliculi ignoti.—COLOMBIA: vicinity of Santa Marta, alt. 2000 ft., June, 1898–1901, *H. H. Smith 2410* (Herb. Missouri Bot. Gard., TYPE).

Metalepis cubensis Griseb. *(Cynanchum cubense* (Griseb.) Woods.), under which this specimen was distributed, differs conspicuously in the smaller, nearly triangular leaves, in the uniformly papillate corollas, and in structural characters of the gynostegium and pollinia. A discussion of *Metalepis* as a

subgenus of *Cynanchum* will be found in ANN. MISSOURI BOT. GARD. **28**: 213–214. 1941.

CYNANCHUM (METALEPIS) **Haughtii** Woodson, spec. nov. Frutex volubilis graciliusculus; ramulis minutissime pilosulis glabratisve. Folia petiolata ovato-cordata basi vix lobata fere rotundato-subtruncata 9–12 cm. longa 7–8 cm. lata apice abrupte angusteque acuminata glabra membranacea nervo medio supra basi glanduligero, petiolo 2.5–3.0 cm. longo minutissime pilosulo vel glabro. Inflorescentia axillaris paniculata multiflora foliis ca. dimidia longior, pedunculis dense puberulis, pedicellis 0.4 cm. longis puberulis; calycis laciniis oblongis obtusis 0.3 cm. longis sparse pilosulis; corollae rotatae viridulae lobis ovatis acutis ca. 0.25 cm. longis supra subcucullatis prope apicem incrassatis ibique minute pilosulis caeterumque papillatis vel glabris; gynostegio subsessili apice ca. 0.2 cm. diam., stigmate umbonato; polliniis leviter reniformibus ca. 0.075 cm. longis, caudiculis 0.04 cm. longis, corpusculo minuto; corona pentagulo-rotata ca. 0.225 cm. diam., segmentis angustatis emarginatis conduplicatis inflexis Folliculi ignoti.—ECUADOR: roadside near Paján, alt. ca. 200 m., Dec. 10, 1939, *O. Haught 2985* (Herb. Missouri Bot. Gard., TYPE). Outstanding in the subgenus because of the small flowers and peculiar subcucullate corolla lobes.

MATELEA (HELIOSTEMMA) **inops** Woodson, spec. nov. Frutex volubilis; ramulis graciliusculis ferrugine pilosis, internodiis sat elongatis. Folia opposita petiolata ovata apice acuminata basi late cordata 5.5–9.0 cm. longa 3–5 cm. lata membranacea utrinque ferrugine puberulo-papillata, petiolis 2.5–6.0 cm. longis similiter vestitis. Inflorescentia extra-axillaris umbelliformis pluriflora, pedunculo 0.5–0.7 cm. longo, pedicellis 1.5–2.0 cm. longis puberulo-papillatis. Calycis lobi ovati acuti 0.4 cm. longi puberulo-papillati pilis longioribus interspersis. Corolla rotata ut creditur viridula ca. 2 cm. diam. extus intusque sparse pilosula; lobis ovatis acutis ca. 0.6 cm. longis. Corona simplicissima disciformis discolorata ca. 0.35 cm. diam. sub antheris inconspicue ligulata. Gynostegium sessile;

stigmate late 5-gono ca. 0.08 cm. diam. depresso; antheris sub stigmate positis, polliniis obpyriformi-subfalciformibus valde excavatis cum caudiculo plicate alato fere aequilongo ca. 0.07 cm. longis, corpusculo mediocri.—MEXICO: CHIAPAS: Cascada Siltepec, Aug. 5, 1937, *E. Matuda 1731* (Herb. Missouri Bot. Gard., TYPE; Herb. Univ. Michigan, ISOTYPES). Noteworthy amongst the other liana species of subgen. *Heliostemma* because of the very simple discoid corona, somewhat resembling that of the fruticulose *M. caudata.*

MATELEA (HELIOSTEMMA) **tinctoria** Woodson, spec. nov. Frutex volubilis; ramulis graciliusculis glabris, internodiis sat elongatis. Folia opposita longe petiolata late ovata apice abrupte angusteque subcaudato-acuminata basi rotundata vel obscurissime cordata 14–17 cm. longa 7–11 cm. lata membranacea glabra post exsiccationem sordide purpureo-discolorata, petiolis ca. 5 cm. longis. Inflorescentia extra-axillaris longe pedunculata racemiformis pauciflora, pedunculo ca. 8 cm. longo, pedicellis ca. 2 cm. longis dense minuteque ferrugineo-papillatis; calycis lobis ovato-lanceolatis acuminatis ca. 1.2 cm. longis extus minutissime ferrugineo-papillatis; corolla campanulato-rotata viridula glabra vel extus indistincte papillata post exsiccationem dilute livido-discolorata, faucibus late campanulatis ca. 0.5 cm. altis ca. 1.2 cm. diam, lobis triangularibus acutis ca. 1.5 cm. longis patulis; gynostegio breviter stipitato, stigmate late 5-gono ca. 0.35 cm. diam.; antheris sub stigmate positis sed appendicibus apicalibus cerocandidis super eo convergentibus, polliniis triangulo-falciformibus in caudiculo gradatim attenuatis ca. 0.1 cm. longis, corpusculo mediocri; corona carnosa rotata simplici profunde 5-lobata per partitiones 5 carnosas ad gynostegium annexa. Folliculi ignoti.—COSTA RICA: Vara Blanca de Sarapiquí, north slope of Central Cordillera, between Poás and Barba volcanoes, alt. 1890 m., Febr., 1938, *A. F. Skutch 3589* (U. S. Nat. Herb., TYPE). Closely related to *M. picturata* (Hemsl.) Woods. and *M. Pittieri* (Standl.) Woods., but probably more closely to the latter, from which it is distinguished by its much larger flowers and leaves as well as by the more simple structure of

the corona. The leaves of these three species, as well as others of the subgenus *Heliostemma,* produce a peculiar blackish purple dye upon wilting, as do the flowers also to a lesser extent. The peculiar whitened anther appendages are noteworthy also.

MATELEA (EUMATELEA?) **cynanchiflora** Woodson, spec. nov. Suffrutex volubilis dense ferrugineo-pilosulus; ramulis graciliusculis, internodiis sat elongatis. Folia opposita oblongo-elliptica apice anguste acuminata basi obtusa 6.0–10.5 cm. longa 2–4 cm. lata membranacea utrinque ferrugineo-pilosa, petiolis 1.0–1.25 cm. longis. Inflorescentia extra-axillaris sessilis umbelliformis pluriflora, pedicellis 1.0–1.3 cm. longis ferrugineo-pilosis; calycis lobis ovatis acuminatis 0.15 cm. longis extus ferrugineo-pilosulis; corolla rotata luteo-albida ca. 1.2 cm. diam., lobis late ovatis rotundatis ca. 0.4 cm. longis extus sparse pilosulis intus minute papillatis; corona cyathiformis ca. 0.15 cm. alta 0.3 cm. diam. margine subintegra per partitiones 5 carnosas ad gynostegium annexa; gynostegio manifeste (ca. 0.15 cm.) stipitato, stigmate late 5-gono ca. 0.2 cm. diam.; antheris sub stigmate positis, polliniis oblique obpyriformibus fere subfalciformibus cum caudiculo ca. 0.075 cm. longis. Folliculi ignoti.—COSTA RICA: vicinity of El General, Prov. San José, alt. 640 m., Jan., 1939, *A. F. Skutch 4071* (U. S. Nat. Herb., TYPE). The deep cyathiform corona is quite unusual for *Matelea,* and the whole superficial aspect of the plant suggests *Cynanchum.* The pollinia, on the other hand, show the species to be Gonoloboid. It is not closely related to any other known species of *Eumatelea,* and may eventually necessitate the erection of a separate subgenus.

MATELEA (EUMATELEA) **Steyermarkii** Woodson, spec. nov. Frutex volubilis; ramulis graciliusculis ferrugineo-pilosis tandem glabratis, internodiis sat elongatis. Folia oblongo-ovata apice anguste acuminata basi sat indistincte cordata 5–9 cm. longa 1.5–3.0 cm. lata membranacea utrinque ferrugineo-pilosa, petiolis 1.5–2.5 cm. longis ferrugineo-pilosis. Inflorescentia umbelliformis pauciflora, pedunculo 2.5 cm. longo, pedicel-

lis 1.5 cm. longis ut in pedunculo ferrugineo-pilosis; calycis laciniis oblongo-ovatis acuminatis 0.7–0.8 cm. longis extus ferrugineo-pilosulis; corolla rotata alba venis venulisque insigniter viridibus extus intusque glabra vel minutissime papillata, lobis ca. 1.2 cm. longis late ovatis rotundatis patulis; gynostegio 0.4 cm. alto; antheris sub stigmate positis, polliniis excavato-pyriformibus cum caudiculo pellucido ca. 0.1 cm. longis, corpusculo mediocri; corona complicata urceolata ca. 0.3 cm. alta ca. dimidia superiori profunde multifissa basi paulo inflata integra (an corollae fauces ?) minutissime papillata per digitos 5 carnosos anguste oblongos ca. 0.2 cm. longos ad gynostegium annexa. Folliculi ignoti.—GUATEMALA: DEPT. SAN MARCOS: upper south-facing forested slopes of Volcán Tajumulco, between Canojas and top of ridge, 7 mi. from San Sebastián, alt. 3300–3900 m., Febr. 16, 1940, *Steyermark 35810* (Herb. Missouri Bot. Gard., TYPE).—This species well illustrates the tremendous complexity of the corona of most species of *Matelea.* The radial partitions of the corona are so conspicous that they are apt to be mistaken for the dorsal anther appendages of *Gonolobus,* from which they are quite distinct morphologically.

MATELEA (EUMATELEA § RETICULATAE) **tenuis** Woodson, spec. nov. Frutex volubilis; ramulis tenuibus inconspicue pilosulis, internodiis sat elongatis. Folia opposita elliptico-oblongata apice acuminata basi obtusa 5–7 cm. longa 1.5–2.3 cm. lata delicate membranacea glabra; petiolis 0.5–0.7 cm. longis inconspicue pilosulis. Inflorescentia extra-axillaris racemiformis pauciflora, pedunculo ca. 0.3–0.5 cm. longo minute papillato, pedicellis ca. 0.5 cm. longis minute puberulo-papillatis. Flores ut dicuntur virides. Calycis lobi late ovati acuti 0.25 cm. longi extus puberulo-papillati. Corolla rotato-subcampanulata ca. 1 cm. diam.; lobis ovatis obtusis ca. 0.3 cm. longis extus intusque minute papillatis. Corona patelliformis obscure 5-lobata caeterumque integra ca. 0.4 cm. diam. per partitiones 5 latas adscendentes ad gynostegium annexa. Gynostegium ca. 0.2 cm. stipitatum; stigmate late 5-gono ca. 0.2 cm. diam.; antheris sub stigmate positis, polliniis horizontalibus obpyri-

formibus profunde excavatis cum caudiculis ca. 0.1 cm. longis, corpusculo mediocri. Folliculi ignoti.—GUATEMALA: IZABAL: vicinity of Quirigua, alt. 75–225 m., May 15–31, 1922, *P. C. Standley 24036* (Gray Herb., TYPE). Outstanding amongst the species of § *Reticulatae* because of the thin, narrow leaves and the small, subcampanulate corollas.

MATELEA (EUMATELEA) **violacea** Woodson, spec. nov. Frutex volubilis; ramulis ferrugineo-pilosis, internodiis sat elongatis. Folia late oblongo-ovata apice anguste acuminata basi late cordata 9–13 cm. longa 4–6 cm. lata membranacea utrinque pilosa, petiolis 3.0–3.5 cm. longis ferrugineo-pilosis. Inflorescentia subsessilis pauciflora, pedunculo ca. 0.5 cm. longo piloso, pedicellis ca. 1 cm. longis pilosis; calycis laciniis late ovatis anguste acuminatis extus ferrugineo-pilosis; corolla rotata violacea venis venulisque reticulatis brunneo-purpurascentibus extus laxe ferrugineo-pilosa intus minute papillata, lobis late ovatis obtusis ca. 0.5 cm. longis patulis; gynostegio sessili; antheris pro parte sub stigmate positis, polliniis excavato-pyriformibus cum caudiculis latis pellucidis ca. 0.15 cm. longis, corpusculo mediocri, stigmate subplano late 5-gono ca. 0.3 cm. diam.; corona rotata patula late 5-lobata ca. 1 cm. diam. complicate multifissa per digitos 5 inconspicuos ad gynostegium annexa. Folliculi ignoti.—GUATEMALA: DEPT. SAN MARCOS: between Canjulá and La Unión Juárez, near southeast portion of Volcán Tacaná, alt. 2000–3000 m., Febr. 22, 1940, *J. A. Steyermark 36445* (Herb. Missouri Bot. Gard., TYPE; Herb. Field Mus., ISOTYPE).—Beside the peculiar coloration of the corolla, this species is distinguished by much the same fimbriation of the corona as in *M. Steyermarkii,* but in rotate form and with very much less conspicuous radial partitions.

MATELEA (LABIDOSTELMA) **Hintoniana** Woodson, spec. nov. Frutex volubilis sat validus; ramulis ferrugine strigoso-pilosis, internodiis sat elongatis. Folia opposita late ovata apice acuminata basi late cordata 6–10 cm. longa 3.5–6.5 cm. lata membranacea utrinque pilosula, petiolis 4.5–6.0 cm. longis sparse pilosulis. Inflorescentia extra-axillaris laxe racemi-

formis pluriflora, pedunculo 3.0–3.5 cm. longo pilosulo, pedicellis 2.5–3.0 cm. longis similiter vestitis; bracteis ovato-lanceolatis 0.5–0.7 cm. longis subfoliaceis pilosulis; calycis lobis elliptico-lanceolatis acuminatis ca. 1.2 cm. longis subfoliaceis pilosulis; corolla late campanulato-rotata fere plana ca. 4 cm. diam. speciosa praecipue ad lobos roseo-tincta et more subgen. *Dictyanthi* reticulata; lobis late triangularibus acutis ca. 1 cm. longis; corona complicate 5-lobata, lobis 3-lobulatis more *M. Quirosii (Labidostelma guatemalense)* compositis; gynostegio subsessili, stigmate obtuse 5-gono depresso. Folliculi ignoti.—Mexico: Bejucos, alt. 610 m., District of Temascaltepec, Mexico, Aug. 24, 1932, *G. B. Hinton 1450* (Gray Herb., type). Closely related to *M. Quirosii* (Standl.) Woods. *(Labidostelma guatemalense* Schltr., which has somewhat smaller flowers with ovate-acuminate lobes, not conspicuously reticulate as in *M. Hintoniana.*

Matelea (Ibatia ?) **glaberrima** Woodson, spec. nov. Frutex volubilis glaberrimus; ramulis validiusculis, internodiis longissimis. Folia ovato-elliptica apice acuminata basi rotundata 13–18 cm. longa 5–11 cm. lata; petiolis 1–3 cm. longis. Inflorescentia umbelliformis pauciflora, pedunculo subnullo, pedicellis ca. 1 cm. longis. Flores ut dicuntur virides brunneique. Calycis lobi ovato-lanceolati acuminati 0.5 cm. longi extus minutissime puberulo-papillati. Corolla rotata extus glabra intus puberulo-papillata ca. 1.75 cm. diam.; lobis ovato-ellipticis acutis ca. 0.8 cm. longis patulis. Corona poculiformis valde 5-gona margine undulata, sinis margine 2-lamellatis ibique ligula inconspicua munitis, anguli margine revoluti. Gynostegium substipitatum; stigmate valde 5-gono depresso; antheris sub stigmate positis, polliniis a corpusculo aliquantulum descendentibus cum caudiculis brevibus ca. 0.15 cm. longis, corpusculo mediocri. Folliculi ignoti.—Guatemala: peten: Uaxactun, March 24, 1931, *H. H. Bartlett 12300* (Herb. Missouri Bot. Gard., type; Herb. Univ. Michigan, isotype). This species is rather intermediate between the subgenera *Ibatia* and *Macroscepis.* In my key to the subgenera of *Matelea,* it will fall into the former after some persuasion, but it is probable that

a new subgenus will have to be erected for it eventually, since it is quite unlike any other described species, especially with regard to the peculiar corona, as well as the large coriaceous leaves.

GONOLOBUS **lanugiflorus** Woodson, spec. nov. Frutex volubilis omnino fulvo-hispidus; ramulis crassiusculis. Folia late oblongo-ovata apice abrupte angusteque subcaudato-acuminata basi late cordata 9–14 cm. longa 4.5–7.5 cm. lata membranacea, petiolis 2.0–3.0 cm. longis. Inflorescentia umbelliformis subsessilis, pedicellis ca. 1 cm. longis. Flores viriduli; calycis lobis lanceolatis acuminatis ca. 1 cm. longis; corollae rotatae extus intusque fulvo-hispidulae lobis ovato-lanceolatis anguste acuminatis ca. 1.5 cm. longis, annulo faucium bene manifesto ca. 0.05 cm. alto minute fulvo-hispidulo integro; corona rotata per saepta 5 radialia 5-partita margine minutissime crenulata glabra; gynostegio subsessili ca. 0.45 cm. diam; antheris circum stigma positis, appendiculis bene manifestis carnosis lobis valde divaricatis obtusis ca. 0.1 cm. longis, polliniis subhorizontalibus excavato-pyriformibus cum caudiculo lato pellucido ca. 0.15 cm. longis, corpusculo magno sagittato ca. 0.05 cm. longo, stigmate 5-gono umbonato. Folliculi ignoti.—GUATEMALA: DEPT. SAN MARCOS: vicinity of town of Tajumulco, northwestern slopes of Volcán Tajumulco, alt. 2300–2800 m., Febr. 28, 1940, *J. A. Steyermark 36906* (Herb. Missouri Bot. Gard., TYPE; Herb. Field Mus., ISOTYPE).—The uniformly dense, fulvous indument and subsessile cymes of this species are quite different from any species of the genus known to me.

GONOLOBUS **longipetiolatus** Woodson, spec. nov. Frutex volubilis; ramulis gracillimis laxe fulvo-hispidulis, internodiis sat elongatis. Folia oblongo-elliptica vel -ovata apice subcaudato-acuminata basi obtusa vel indistincte cordata 4.5–9.0 cm. longa 2–4 cm. lata delicate membranacea glabra; petiolis tenuibus 2–5 cm. longis glabris. Inflorescentia subracemiformis, pedunculo 2.0–2.5 cm. longo papillato, pedicellis aequalibus; calycis lobis anguste lanceolatis longe acuminatis ca. 0.7 cm.

longis extus minute papillatis intus glabris; corollae rotatae glabrae viridis lobis ovato-oblongis acuminatis 0.9 cm. longis marginibus valde involutis interioribus albis inter se conspicue calcaratis, faucibus leviter annulatis; corona conspicue 5-lobata, lobis erectis late oblongis ca. 0.2 cm. longis apice truncatis vel paululo emarginatis marginibus subconduplicatim revolutis; gynostegio longiuscule (0.2 cm.) stipitato; antheris sub stigmate positis, appendiculis ovatis integris ca. 0.15 cm. longis carnosis patulis, polliniis excavato-pyriformibus cum caudiculo lato pellucido ca. 0.1 cm. longis, corpusculo minuto anguste sagittato; stigmate anguste 5-gono ca. 0.35 cm. diam. conspicue rostrato. Folliculi ignoti.—GUATEMALA: DEPT. SAN MARCOS: above Finca El Porvenir, up Loma Bandera Shac, lower south-facing slopes of Volcán Tajumulco, alt. 1300–1500 m., March 9, 1940, *J. A. Steyermark 37428* (Herb. Field Mus., TYPE).—Closely related to such species as *G. Lundellii* and *G. cteniophorus*, but differing in the entirely glabrous corolla and peculiar erect corona lobes.

GONOLOBUS **Steyermarkii** Woodson, spec. nov. Frutex volubilis; ramulis sparse fulvo-hispidulis, internodiis sat elongatis. Folia ovato- vel oblongo-elliptica apice subcaudato-acuminata basi late subauriculato-cordata 7–25 cm. longa 2.5–12.0 cm. lata firme membranacea utrinque pagina sparsius nervo medio basi supra densius fulvo-hispidula, petiolis 2–6 cm. longis sparse hispidulis. Inflorescentia racemiformis rarius corymbiformis, pedunculo 2–4 cm. longo saepissime simplici rare 2-fido minute papillato, pedicellis 2.5–3.0 cm. longis sparse pilosulis; calycis lobis oblongo- vel ovato-lanceolatis acuminatis ca. 1.5 cm. longis ca. 0.5–0.7 cm. latis foliaceis glabris vel inconspicue papillatis; corollae rotatae dilute viridis glabrae lobis late oblongo-ellipticis adscendentibus late acutis marginibus revolutis ca. 1.2 cm. longis ca. 0.5 cm. latis, faucibus annulatis ca. 0.4 cm. altis ostio dense pilosis caeterumque glabris albidis; corona annulata margine minute crenulata corollae faucibus adnata et eis aequilonga per saepta 5 radialia 5-partita; gynostegio longiuscule (ca. 0.45 cm.) stipitato; antheris sub stigmate positis, appendiculis dorsalibus an-

guste 2-lobatis, lobis angustis divaricatis ca. 0.1 cm. longis, polliniis excavato-pyriformibus cum caudiculis latis pellucidis ca. 0.15 cm. longis, corpusculo mediocri, stigmate anguste 5-gono ca. 0.4 cm. diam. inconspicue umbonato. Folliculi ignoti. —GUATEMALA: DEPT. SAN MARCOS: along Rio Negro near Finca La Pátria, Volcán Tajumulco, alt. 1300–1400 m., March 13, 1940, *J. A. Steyermark 37661* (Herb. Missouri Bot. Gard., TYPE; Herb. Field Mus., ISOTYPE); DEPT. QUEZALTENANGO: slopes and ridges between Quebrada Chicharro and Montana Chicharro, on southeast-facing slopes of Volcán Santa Maria, alt. 1300–1400 m., Jan. 18, 1940, *J. A. Steyermark 34342* (MBG; FM); DEPT. SUCHITEPEQUEZ: southwestern lower slopes of Volcán Zunil, vicinity of Finca Asturias, northeast of Pueblo Nuevo, alt. 1200–1300 m., Febr. 1, 1940, *J. A. Steyermark 35317* (MBG, FM).—A species of the *Trichostelma* complex, differing from *G. stenosepala (Fimbristemma stenosepala)* in the nearly glabrous corolline faucal annulus, and from *G. calycosus (Trichostelma ciliatum; Fimbristemma calycosa)* in the narrower calyx lobes. Our species differs from both in the very scanty indument. Although the three species undoubtedly are very closely related and may subsequently be shown to represent mere varieties of a single species, the constancy of Steyermark's three collections casts some doubt upon that view at this time.

MARSDENIA **pseudo-edulis** Woodson, spec. nov. Frutex volubilis; ramulis graciliusculis rimosis juventate minute puberulo-papillatis. Folia latiuscule elliptica acute acuminata basi late obtusa 4.5–11.0 cm. longa 1.5–5.0 cm. lata membranacea glabra, petiolis 1.0–2.5 cm. longis puberulo-papillatis. Inflorescentia umbelliformis pauciflora, pedunculo ca. 0.5 cm. longo sparse pilosulo, pedicellis similibus; calycis laciniis ovatis obtusis 0.2 cm. longis pilosulis, corollae campanulatae albae extus sparse intus dense pilosulae tubo ca. 0.2 cm. longo, ostio ca. 0.25 cm. diam. ibique inter lobos umbonibus 2 munito; lobis ovato-ellipticis obtusis 0.3 cm. longis patulis; gynostegio corollae tubum aequante, stigmate plano vel paululo depresso; antheris ca. 0.1 cm. longis simplicibus, polliniis pyriformibus

vix 0.05 cm. longis caudiculo aequilongo; coronae squamis reniformibus obtusis ca. 0.05 cm. longis. Folliculi ignoti.—GUATEMALA: DEPT. QUEZALTENANGO: lower south-facing slopes of Volcán Santa Maria, between Santa Maria de Jesus and Calahuaché, along great barranco between Finca Pirineos and San Juan Patzulin, alt. 1300–1500 m., Jan. 6, 1940, *J. A. Steyermark 33633* (Herb. Field Mus., TYPE).—Apparently somewhat intermediate between the sections *Pseudomarsdenia* and *Ruehssia.*

MARSDENIA **Steyermarkii** Woodson, spec. nov. Frutex volubilis ut dicitur epiphyticus fere omnino glaber; ramulis crassiusculis glabris, internodiis sat elongatis. Folia oblongo-elliptica apice abrupte acuminata basi rotundata 6–10 cm. longa 2.0–3.5 cm. lata subcoriacea glabra, petiolis 1–2 cm. longis. Inflorescentia modo dichasialis pauciflora, pedunculo 2-fido ca. 2.5 cm. longo glabro, pedicellis ca. 0.4 cm. longis obscure puberulo-papillatis; calycis laciniis ovatis acutis 0.2 cm. longis minutissime puberulo-papillatis. Corolla campanulata alba extus glabra intus pilosula tubo ca. 0.3 cm. longo ca. 0.4 cm. diam. intus dense pilosulo; lobis ovatis obtusis 0.25 cm. longis sparse pilosulis patulis; gynostegio ca. 0.3 cm. longo; antheris ca. 0.2 cm. longis, polliniis cum caudiculo ca. 0.02 cm. longis corpusculum superantibus; coronae squamis ca. 0.2 cm. longis stigma latum conicum superantibus dimidia inferiore late trigonis deinde in ligulam sublinearem productis. Folliculi ignoti.—GUATEMALA: DEPT. SAN MARCOS: along Quebrada Canjulá, between Sibinal and Canjulá, Volcán Tacaná, alt. 2200–2500 m., common on cut-over slopes, epiphyte, Febr. 18, 1940, *J. A. Steyermark 36019* (Herb. Field Museum, TYPE).—This species apparently is the only known Central American member of the section *Verlotia.*

ASCLEPIAS **Scheryi** Woodson, spec. nov. Herba perennis robusta ca. 2 m. alta; caule superiore valido sparsiuscule tomentello. Folia opposita sessilia late trigono-ovata basi late rotundata vel subtruncata apice subrotundata abrupteque mucronulata superiora 13–15 cm. longa 8–12 cm. lata membranacea supra sparsius subtus densius tomentella nervo medio valido venis secondariis multis late arcuatis. Inflores-

centiae ut videntur saepissime binis laterales multiflorae, pedunculis 6–8 cm. longis minute tomentellis, pedicellis vix 2 cm. longis filiformibus similiter vestitis. Flores lactei purpureo-tincti. Calycis lobi ovato-oblongi acuminati ca. 0.4 cm. longi extus minute pilosuli. Corollae rotatae lobi ovato-elliptici acuti vel minutissime emarginati ca. 0.7 cm. longi patenti extus densius intus sparsius puberulo-papillati. Gynostegii columna ca. 0.08 cm. longa ca. 0.25 cm. crassa; foliolis paliformibus brevissime substipitatis ca. 0.5 cm. longis dorso subcarinatis, margine superiore late rotundato, lobis lateralibus rotundatis dimidia brevioribus, corniculo juxta basim affixo ca. 0.5 cm. longo super stigmate abrupte inflexo; antheris ca. 0.25 cm. longis, alis basi prominentibus; polliniis rhombo-obpyriformibus cum caudiculis ca. 0.175 cm. longis, corpusculo mediocri. Folliculi maturi non visi immaturi late fusiformi laeves tomentelli.—Mexico: michoacan: pine woodland near Uruapan, alt. 1850 m., July 16, 1941, *R. W. Schery 167* (Herb. Missouri Bot. Gard., type). The leaves of this species are very distinctive, and are comparable only to those of *A. lanuginosa,* although less densely tomentose beneath. The flowers of *A. Scheryi,* however, are quite different from those of *A. lanuginosa,* in which the hoods are gradually acute and more than twice as long as the anther head.

THE TECHNIQUE AND USE OF MASS COLLECTIONS IN PLANT TAXONOMY

EDGAR ANDERSON

Geneticist to the Missouri Botanical Garden

Engelmann Professor in the Henry Shaw School of Botany of Washington University

A slight extension of ordinary herbarium techniques promises to increase the accuracy of herbarium studies and greatly to widen their scope. Attention was called to the possibility in 1935.[1] Since that time its potentialities have become increasingly evident and details of its technique have been considerably improved. The method consists in supplementing ordinary specimens by mass collections made as described in detail below. For small plants these mass collections may well consist of the entire plant. For larger plants considerations of space require the selection of some critical portion, as the leaves, the infloresence, or the fruits. For instance, in studying sugar maples (*Acer saccharum* and its relatives) a mass collection will consist of one leaf per tree (carefully selected from the same kind of non-fruiting branch) from thirty to fifty trees, and complete specimens of the usual sort, from two or three of the trees. Properly made and filed (see below) mass collections require only a little more space than ordinary herbarium specimens.

Such a collection is a record of a population as well as of the individuals which make up that population, and it therefore gives the facts about variation which can be obtained from populations but not from individuals. In other words, it would bring into the herbarium information which now we can get only in the field. This information can be grouped under three different heads.

(1) *Frequency of the variation.*—The most important defect of the ordinary herbarium material, in biometrical terminology, is that, while it may give a reliable estimate of the

[1] Anderson, Edgar, and W. B. Turrill. Biometrical studies on herbarium material. Nature **136**: 986.

range of variation, it does not allow an estimate of the frequencies within that range. That is to say, in non-mathematical language, that it may give a good idea of extremes but it does not indicate the relative prevalence of the extremes or of any particular intermediate. It is not enough to know that a variant exists; for its complete interpretation one needs to know how often it occurs in the places where it has been reported. As Dr. Fassett has put it in a homely analogy: "there are Democrats and Republicans in both Mississippi and Vermont but their comparative frequency varies significantly between these two regions."

(2) *Discontinuity of variation.*—This is potentially one of the greatest sources of error with present-day techniques. The chief criterion for separating taxonomic entities is the degree of morphological discontinuity between them. At the present time it takes good judgment and often field experience to decide if the discontinuity shown by a group of herbarium specimens is real or only apparent. This is particularly true for categories smaller than the species.

(3) *Correlation between variables.*—While an estimate of this correlation can be obtained from ordinary herbarium specimens, it can be derived much more precisely from mass collections and can be perceived more readily and its perception requires less biological judgment. Those who have undertaken monographic work will have encountered complexes in which variation was so extreme and involved so many different characters that it was difficult to comprehend. Mass collections make it possible to study such complexes analytically and to determine precisely the extent to which the variation in different characters is correlated. Anderson and Turrill,[2] for instance, by using mass collections, were able to resolve the variation in the *Fraxinus Pallisae* complex into two elements and to relate these elements to species of *Fraxinus* from southeastern Europe.

There are two problems in making mass collections: what

[2] Statistical studies on two populations of Fraxinus. New Phytol. **37**: 160–172. 1936.

part of the plant to collect and the selection of a random sample of the population. The first is not as difficult as it may seem to anyone who has not tried it. Taxonomic studies on the customary herbarium material are a necessary foundation for the making of mass collections intelligently, and the study of a taxonomic revision will tell what parts are significant and should be collected in quantity. The portion of the plant chosen for intensive collection should provide good morphological criteria; it should be easy to press and store in quantity; and its selection should be definable in precise terms. The following examples may make these points clear: *Tripsacum,* the terminal inflorescence of each plant; *Monarda,* an average flower-head from each plant, with its subtending bracts; *Veronica peregrina,* the entire plant. Wherever possible mass collections should be a series of one sample from each plant. Occasionally a single vegetatively reproduced individual (technically known as a clone) may cover a very large area, and it may be difficult or impossible to know where one individual leaves off and another begins. This is particularly true in such plants as *Sanguinaria canadensis* whose rhizomes grow and branch vigorously and the organic connection between two branches usually rots away after a few years leaving them physically separate. In most cases a careful study of flower and leaf variation will reveal the probable extent of each clone, and a careful collector can minimize the chances of gathering a disproportionate number of samples from a single clone.

The problem of a truly random sample is difficult, and bristles with difficulties which are not even suspected by the uninitiated. One should bear in mind that he is trying to make a record of a population of individuals and that the record will have the greatest significance if it is chosen at random from an actual inter-breeding population. Lacking the precise information as to what an "actual inter-breeding population" may be, one can only use his biological judgment in selecting for each case an area which presents uniform conditions for that species and make his collections from that area. Even for those species which grow in definite, more or less isolated colonies, the

trained eye can often find evidence for distinctive neighborhoods within such communities, and it will be a matter of individual judgment whether these neighborhoods should be recognized or ignored in making a sample of the population. When the area has been chosen one may either collect a specimen from each individual within that area, if there be not too many, or make a random selection of thirty to one hundred or more individuals. One can walk across it in a straight line, making collections at every second or third step, or can use

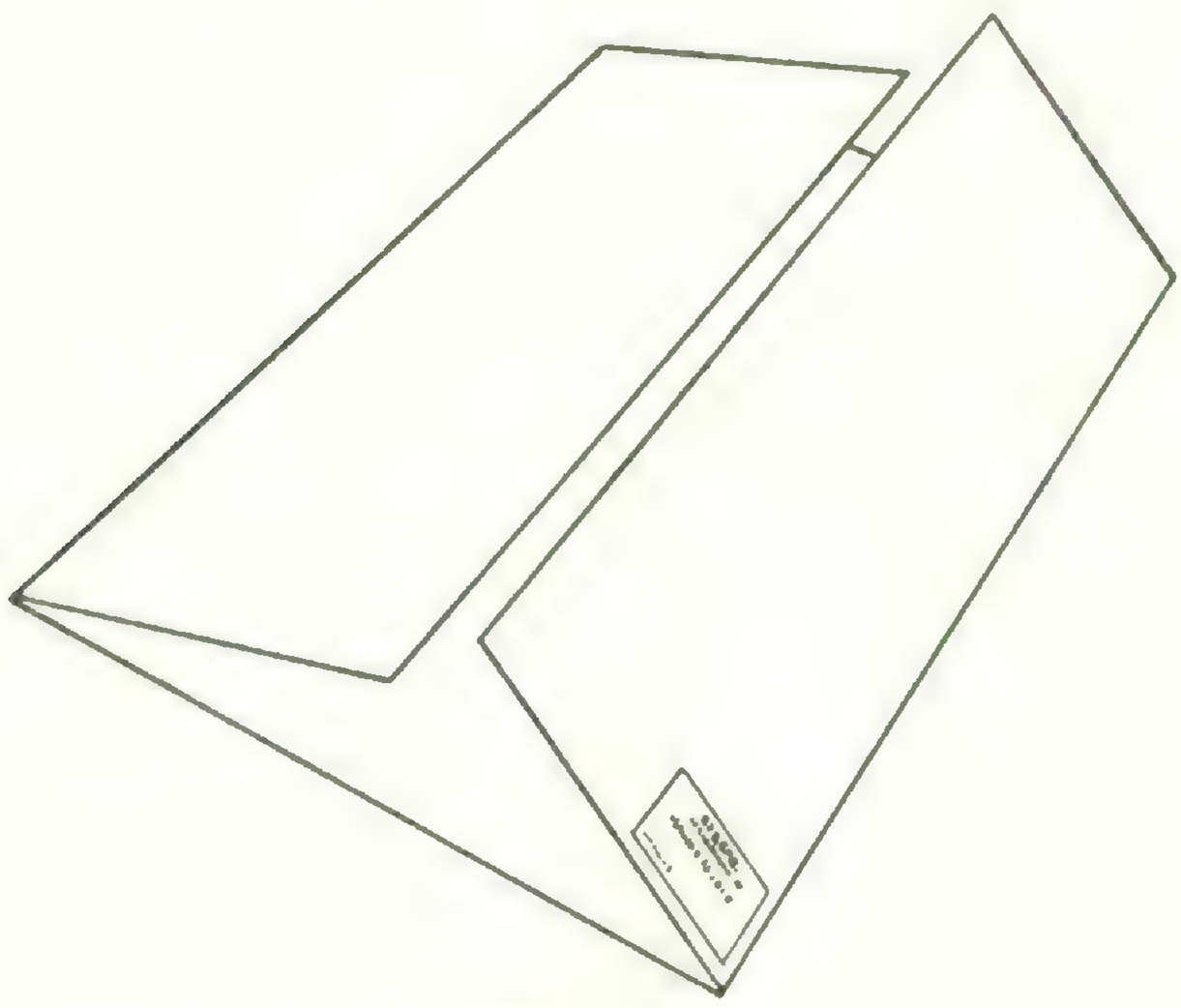


Figure 1.

strings and collect every individual which is touched by the string or is close to it.

If properly made, mass collections do not take up more space than a few herbarium sheets, and they give information which cannot be obtained from hundreds of ordinary specimens. If supplemented by complete specimens there should be no objection to their fragmentary nature. Technical improvements in storing the collections have been made by my assistant, Mr. Leslie Hubricht, and are illustrated in the accompanying figure. Since my collections are subject to intensive study but are not distributed in an ordinary public herbarium they are kept

unmounted. To prevent the specimens from scattering, the genus covers are folded so that the edges meet down the middle rather than the side. One label is made for each collection and is pasted on the genus cover. The ordinary specimens made at the same time and place are mounted and labeled and are kept in the same genus cover. Each collection is given a geographical name and all are assembled alphabetically under the genus or the species, depending upon the nature of the particular problem.

The information derived from a study of mass collections is useful in two ways. It will, in the first place, aid the systematist in cataloguing the various entities involved, species, varieties, forms, etc. While it may raise more new questions than it may solve old ones, it will aid in the production of monographs whose categories are more accurately adjusted to the variation patterns of their particular genera. Mass collections have for some time been customary in avian taxonomy (see, for instance, Mayr[3]), and Kinsey, in a series of brilliant monographs,[4] has shown their superiority in insect systematics. If taxonomy were to be nothing more than cataloguing and if taxonomists were to confine themselves to the problems raised by their herbaria, mass collections would still be a useful adjunct to herbarium technique and in many critical groups would provide more efficient working material, even when their special difficulties of collecting and filing are considered.

There is no reason, however, why taxonomy should be content to cultivate such a narrow field. If collectors and herbarium administrators could be persuaded to encourage mass collections, critically made and carefully assembled, a second kind of problem could be investigated in herbarium material. The description and analysis of geographical trends in variation, the delimitation and interpretation of centers of variation, the establishment and analysis of variation patterns in

[3] Mayr, Ernst. Speciation phenomena in birds. Amer. Nat. **74**: 249–278. 1940.

[4] Kinsey, Alfred C. The gall wasp genus *Cynips*. A study in the origin of species. Indiana Univ. Studies. **84–86**: 1–577. 1930; The origin of higher categories in *Cynips*. Indiana Univ. Publ. Sci. Ser. **4**: 1–334. 1936.

different genera and families, are only a few of the problems that might well be investigated. It is already possible to correlate information from the field of taxonomy with that from cytogenetics. The time is not far distant when the biochemist of the germplasm will also turn to the taxonomist for morphological evidence derived from studying the products of the germplasms. To speak with authority on such questions taxonomists will need to refine their biological as well as their bibliographical techniques.

MASS COLLECTIONS: CAMASSIA SCILLOIDES

RALPH O. ERICKSON

University Fellow in the Shaw School of Botany of Washington University

In the St. Louis vicinity, *Camassia scilloides* (Raf.) Cory exhibits a considerable amount of variability, which is apparent on looking at a number of plants even casually. This fact has been given some recognition by the description of *C. scilloides* forma *Petersenii* Steyermark.[1] In the spring of 1940 an attempt was made to learn something about the statistical nature of the variation. "Mass collections" (Anderson,[2] Fassett[3]), each consisting of 25–50 or more inflorescences, and in some cases leaves, were made at the places which are cited in detail in the footnote,[4] and which will be referred to as New Athens, Allenton, Meramec Highlands, Gray Summit and Spring Creek, respectively.

The plants of the first collection were first studied to decide what features of the variation could be most satisfactorily submitted to measurement. The dimensions of the inflorescence seemed most promising. The "open" appearance of some of the inflorescences, as contrasted with the compactness of others, seemed obviously related to internode length and pedicel length, and these lengths were measured in plants of each of the collections. There is considerable difference in length between successive internodes, so that instead of measuring a particular one, the length of the lowest eight was used.

[1] Rhodora **40**: 178. 1938.

[2] Ann. Mo. Bot. Gard. **28**: 287–292. 1941.

[3] Ann. Mo. Bot. Gard. **28**: 299–374. 1941.

[4] ILLINOIS. ST. CLAIR CO.: in river-bottom woods, about 1 mile northwest of New Athens, May 7, 1940. MISSOURI. ST. LOUIS CO.: on top of a ridge, 2 miles south of Allenton, S. 10, T. 43N, R. 3E, April 28, 1940; along a steep south slope below the Frisco railroad tracks, at Meramec Highlands, S. 10, T. 44N, R. 5E, May 18, 1940. FRANKLIN CO.: at the "cliff," Missouri Botanical Garden Arboretum near Gray Summit, S. 17 & 20, T. 43N, R. 2E, April 21 and May 5, 1940; on a south slope at Spring Creek, 4 miles northwest of Stanton, May 11, 1940.

The lowest pedicel was measured in each inflorescence. Neither of these lengths changes appreciably after anthesis, and no inflorescences were measured in which at least half of the flowers had not bloomed. As a check, measurements of members of a few supposed clones were made, and were found to agree.

When internode length was plotted against petiole length in a scatter diagram, a simple picture of the variability within each collection was obtained. Not only was there variability

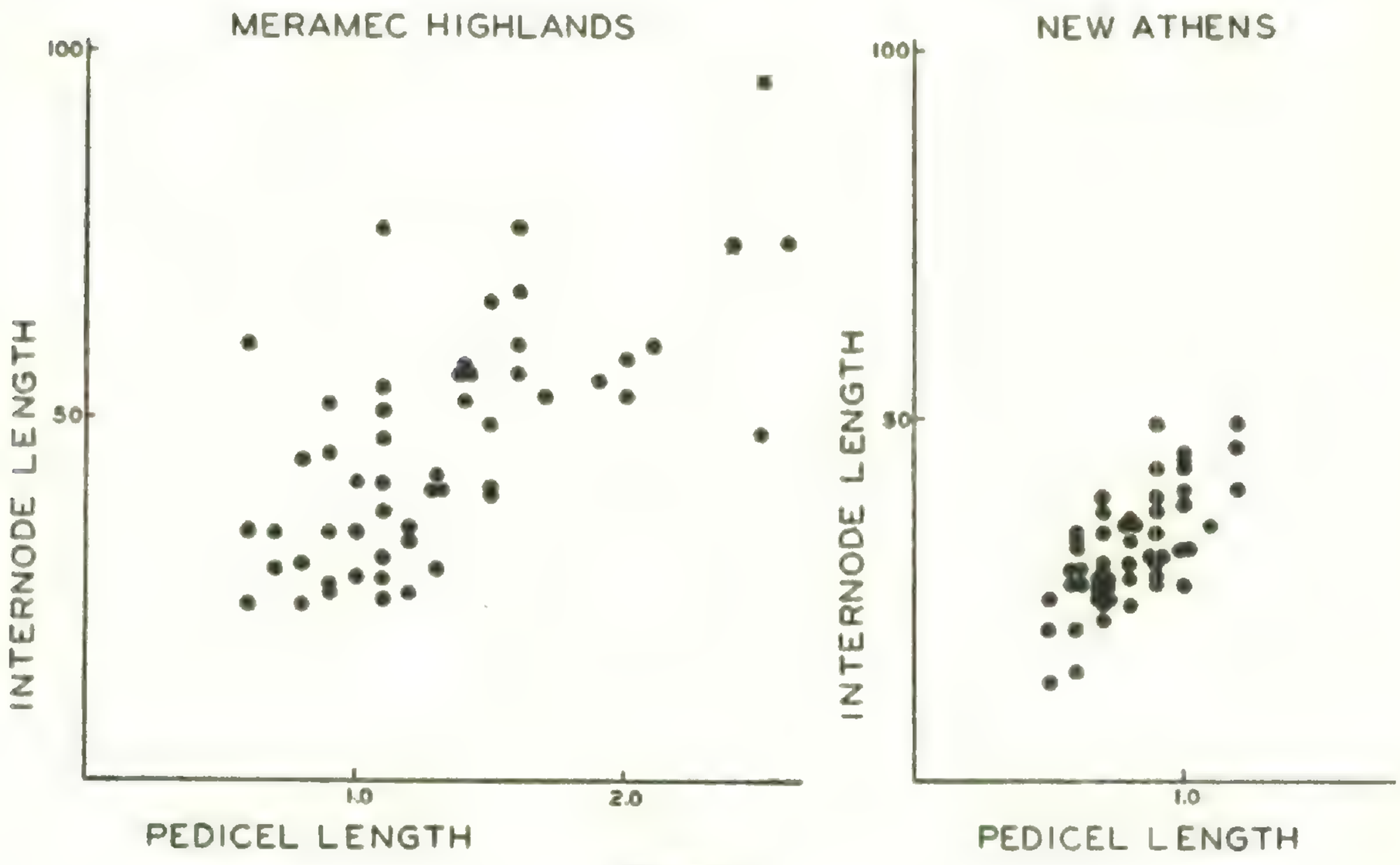


Figure 1.

within each of the colonies, but a striking difference was seen between colonies. The Meramec Highlands, Allenton, Gray Summit and Spring Creek collections, all of which were made within the Ozark region, produced essentially the same sort of scatter diagrams, while that for the New Athens material was quite different (see fig. 1). At New Athens the range of variation in these two characters is quite restricted as compared with Meramec Highlands and the other Ozark stations. Although the Meramec Highlands collection includes practically all the types represented at New Athens, most of the plants from Meramec Highlands lie completely outside the range of variation of the New Athens colony.

The same sort of difference in variability is shown by the scatter diagrams in fig. 2, where sepal length and width, as measured from camera-lucida drawings of fresh material, are plotted. (The difference, however, is not so pronounced; or is it exaggerated in the case of the internode and pedicel lengths by the use of an inappropriate scale?[5])

Furthermore, the uniformity of the New Athens plants as compared with those collected in the Ozark localities is apparent in their general aspect, whether seen in the field or as dried

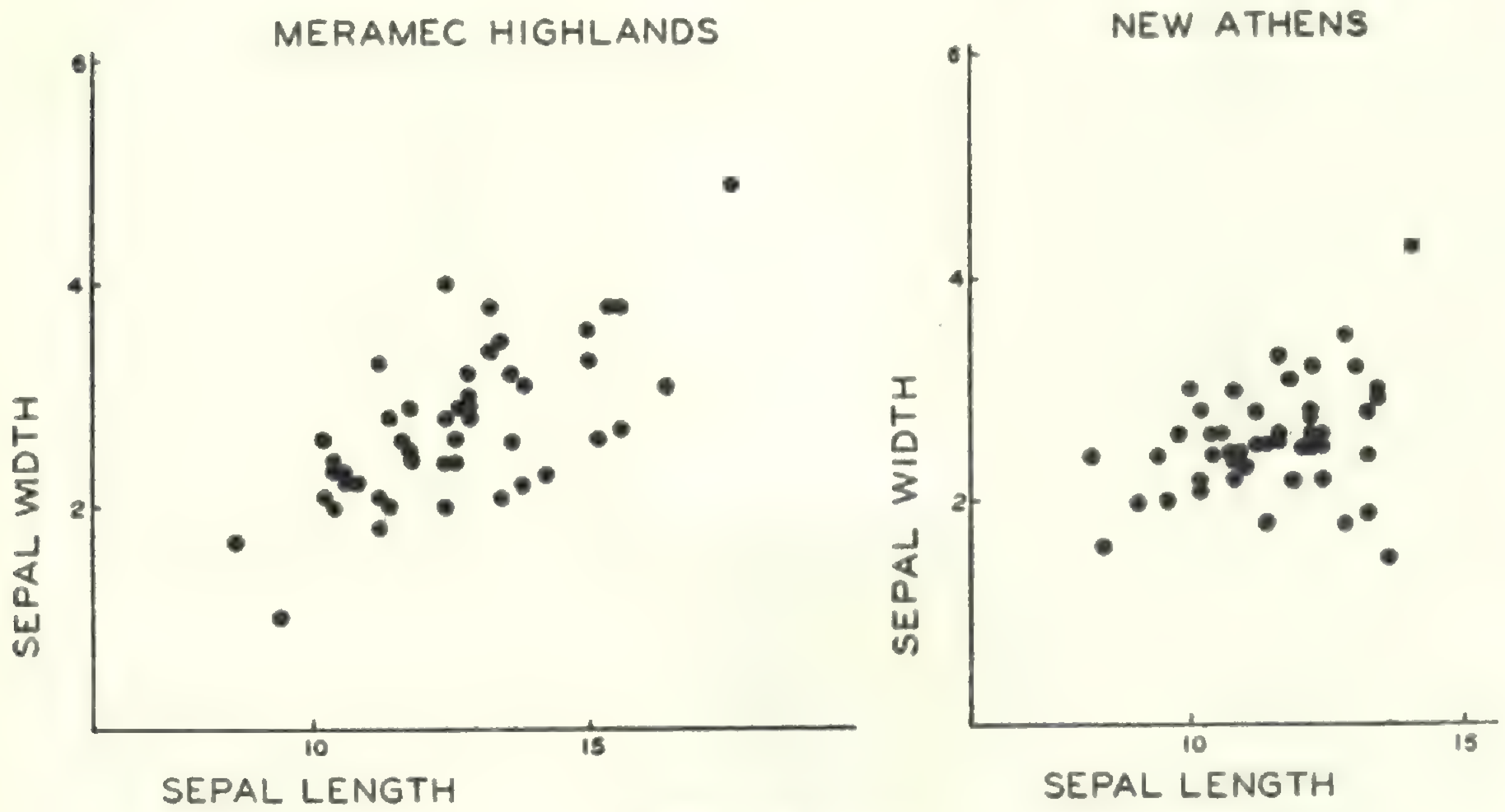


Figure 2.

specimens. See the photographs of dried inflorescences in pl. 8.

Many of the features of the variation which is so apparent in the Camassias of this region cannot be studied statistically, but some of them will be discussed in general terms here. The color of the flowers varies somewhat. While the prevailing color is a pure, pale blue, there is an appreciable range in the depth of the blue color, and in many plants a slight reddish tinge is perceptible. The petals (and sepals) vary both in size and shape, one of the details of the variation being the pres-

[5] Wright in Jour. Amer. Stat. Assoc. **21**: 162–178. 1926.

ence or absence of a sagittate base. It is also easy to see variation in style length and form.

The general aspect of the inflorescence presents easily apparent differences, as mentioned above. There are inflorescences which are decidely cylindrical in shape, and others which appear more or less pyramidal, even when all allowances are made for the acropetal order of flowering. In some plants the inflorescence appears compact, with the flowers greatly crowded; in others it is open and spindly in appearance. The peduncle varies, the extremes being a stout and fleshy sort, and a quite slender and woody one. The bracts are usually inconspicuous and completely withered at anthesis, but plants can be found in which large green bracts, approaching in size the basal leaves, occur at the lowest few nodes of the inflorescence. The largest of these bracts do not subtend flowers. Incidentally, no such large, leaf-like bracts were found among the New Athens plants.

The leaves offer differences in size, and in the amount of bloom on the upper surface. There also appear to be differences in shape of the bulb, which are not connected with its size.

In all of the above-mentioned characters, the New Athens collection is less variable than are the other four.

Although the two collections which have been discussed in detail were made less than fifty miles apart, they are from quite different habitats, and for that matter from different physiographic regions. Meramec Highlands (as well as Allenton, Gray Summit and Spring Creek) is on the northeastern edge of the Ozark Plateau,[6] and at these Ozark localities *Camassia* grows for the most part on steep slopes. New Athens is in the Till Plains section of the Central Lowland,[6] and *Camassia* was there found growing in rich bottom-land soil. The former region is unglaciated, and has been occupied by plants continuously since preglacial times, while the latter was covered by the Illinoian ice sheet.

While it is not the purpose of this paper to offer a complete

[6] Fenneman, Physiography of the eastern United States. New York. 1938.

explanation of the facts presented above, one might suppose that the differences which have been demonstrated between *Camassia* of the Ozarks and of the Illinois bottom-lands are related to the different vegetational histories of the two regions.

EXPLANATION OF PLATE

PLATE 8

Fig. 1. Photograph of ten specimens of *Camassia scilloides* from the mass collection made near New Athens, Ill. Scale is in centimeters.

Fig. 2. Photograph of ten specimens of *Camassia scilloides* from the mass collection made at Meramec Highlands, Mo.

NEW ATHENS

MERAMEC HIGHLANDS

MASS COLLECTIONS: RUBUS ODORATUS AND R. PARVIFLORUS

NORMAN C. FASSETT

Associate Professor of Botany and Curator of the Herbarium,
University of Wisconsin

Contents

I. Variation in *R. odoratus* 300
1. The kinds of variation 300
2. Taxonomy of intraspecific variation 302
3. Geographic occurrence of each form in mass collections 303
4. Correlation of variation with geography 306
II. Variation in *R. parviflorus* 314
1. The kinds of variation 314
2. The "varieties" of *R. parviflorus* 317
3. The forms of *R. parviflorus* 322
4. Occurrence of forms in mass collections 327
5. Is *R. parviflorus* a preglacial relic about the Upper Great Lakes? . . 332
Summary 345

In 1938 a grant was made by the Wisconsin Alumni Research Foundation for the study of the so-called preglacial relics in the flora of the upper Great Lakes region. This study was eventually narrowed to one species, the Thimbleberry or Salmonberry *(Rubus parviflorus)*, whose range shows a gap between Lake Superior and the Black Hills of South Dakota which has been interpreted as due to survival on nunataks about Lakes Superior and Huron. Funds from the estate of the late Dr. J. J. Davis, made available through the generosity of his daughter, Miss Marguerite Davis, made it possible for the writer to carry on this study in the summer of 1939, when the species was collected in South Dakota, Wyoming, Utah and Colorado. Friends in California, Alberta, Wisconsin, Oregon, Colorado, Indiana, New York, Montana and South Dakota have also contributed collections; their names are cited with their collections in tables I and V, and grateful acknowledgement is here made for their assistance, without which this study would not have been possible.

The method used was different from ordinary taxonomic or

Issued September 20, 1941.

ecological techniques: it consisted of collecting many individuals from each colony of Thimbleberry and determining in the laboratory the percentage of plants showing each character. By comparing figures from different regions it has been possible to judge their closeness of relationship; also, some taxonomic changes have been indicated. It became evident that results concerning a plant with a disrupted range like that of *R. parviflorus* were difficult to evaluate in absence of a similar study of a species with an essentially continuous range; accordingly, mass collections were made, in 1938–40, of the eastern *R. odoratus*. Findings in this species will be considered first.

In assembling the distributional data in Maps 12, 24 and 27, the writer is indebted to many friends for assistance; these include Mr. H. D. House, Dr. Earl Core, Dr. T. M. C. Taylor, Dr. J. M. Fogg, Jr., Dr. F. T. McFarland, Dr. E. Lucy Braun, Dr. R. M. Harper, Dr. A. J. Sharp, Dr. F. K. Butters and Dr. Hugh Raup. Maps 10, 12, 19, 20, 21, 24, 25, 26, and 29–34 were prepared from base maps of Hall's 'Outline Maps and Graphs,' published by permission of the author and publisher, John Wiley & Sons, Inc. Maps 35 and 36 are (except for botanical data) from map by Erwin Raisz in Atwood's 'The Physiographic Provinces of North America,' courtesy of Ginn & Co. Professor Walter Cottam, of the University of Utah, has most kindly supplied figs. 5, 6 and 7 of pls. 11 and 12.

I. VARIATION IN *R. odoratus*

1. THE KINDS OF VARIATION

Rubus odoratus, ranging from Nova Scotia and Quebec to Michigan, and southward to Georgia and Tennessee, shows variations which are to a great extent the exact counterparts of those which were described as varieties in *R. parviflorus*.[1] The two pairs of characters (leaves soft-pubescent beneath *vs.* glabrous or glabrate beneath, and pedicels with long-stalked glands *vs.* short-stalked glands) which recombine to make the four "varieties" of *R. parviflorus—hypomalacus, heterade-*

[1] Fernald, Rhodora **37**: 276. 1935.

nius, *bifarius* and *grandiflorus*—appear in just the same combinations in *R. odoratus*. Each of these four combinations ranges essentially throughout the range of the species, so they seem better treated as forms than as varieties.

As in *R. parviflorus*, the distinctions within each pair of characters are not always perfectly marked. Clearly glabrous leaves occur, as do extremely velvety ones, but some intermediates are as difficult to place as they occasionally are in the western species. Many plants have leaves which are appressed-pubescent and feel either harsh or velvety depending on how they happen to have been pressed. In some cases both surfaces are without doubt glabrate, the younger ones appearing densely velvety. In placing these questionable individuals recourse has been had to a character pointed out by Fernald[2]: truly velvety leaves ordinarily bear dark long-stalked glands on their upper surface. The correlation is good, but not perfect, through much of the range of the species. It breaks down completely in two large collections from the unglaciated part of Indiana; here, isolated from the rest of the range for a long time, the plants often have a different appearance (lighter colored, more glabrous and lustrous leaves), frequently carry on the leaves a type of gland not generally found on the species in other parts of the country, and, as has just been stated, lack the usual correlation of glandular upper surfaces with velvety lower surfaces.

The type of gland found mainly in Indiana is on the lower leaf-surfaces along the veins, and has a stalk 2–4 mm. long, which much exceeds those of other forms. Plants with long-stalked glands are not exclusively present in the collections from Indiana, but they outnumber plants with shorter glands.

A plant of very rare occurrence has the glands on the pedicels nearly sessile; this parallels *R. parviflorus* var. *scopulorum* and var. *parvifolius*.

Leaf shapes vary greatly in this species, but because of some variation even on single branches these characters are not as conveniently dealt with as are those of epidermal outgrowths. Examination of any good-sized collection will show singly-

[2] Rhodora **24**: 175. 1922.

toothed and doubly-toothed margins, triangular lobes and oblong-triangular lobes, and depth of lobing varying from ¼ to ½ the radius of the leaf. An individual with deeply lobed leaves has been described as *R. odoratus* var. *columbianus*,[3] or *R. columbianus*.[4]

Sometimes the calyx is covered with a white felt-like tomentum; this proves to be due to the fungus infection *Sphaerotheca humuli*.

2. TAXONOMY OF INTRASPECIFIC VARIATION

To facilitate discussion of these six phases of *R. odoratus* and of the geographic occurrence of the characters on which they are based, it seems advisable to give them names. That the parallelism of five of them with variants of *R. parviflorus* may appear clearly, they are given names identical with or phonetically similar to those used in the more western species.

Rubus odoratus L. f. **hypomalacus,** n.f., foliis subtus velutinis vel subvelutinis, supra fusco-glandulosis; pedicellorum glandulis stipitatis 1–3 mm. longis.—Type, in Herb. Univ. Wis.: roadcut, Ravine, Pa., July 11, 1940, *Fassett 20812. (R. odoratus* var. *malachophyllus* Fernald.)

R. odoratus f. **heteradenius,** n.f., foliis subtus glabris vel glabratis vel sparse appresso-pilosis, supra eglandulosis; pedicellorum glandulis stipitatis 1–3 mm. longis.—Type, in Herb. Univ. Wis.: Wilmington Mountain, east of Bennington, Vt., Aug. 4, 1938, *Fassett 20787*.

R. odoratus f. **bifarius,** n.f., foliis subtus velutinis vel subvelutinis, supra fusco-glandulosis; pedicellorum glandulis stipitatis 0.5–1 mm. longis.—Type, in Herb. Univ. Wis.: cuts and fills along U. S. 6 west of Bear Mountain Bridge, N. Y., July 10, 1940, *Fassett 20806*.

R. odoratus f. **glabrifolius,** n.f., foliis subtus glabris vel glabratis vel sparse appresso-pilosis, supra eglandulosis; pedicellorum glandulis stipitatis 0.5–1 mm. longis.—Type, in Herb. Univ. Wis.: woods and roadside banks 3 miles north of Vassalboro, Me., Aug. 16, 1939, *Fassett 20781*.

R. odoratus f. **scopulorum** n.f., foliis subtus glabris vel glabratis vel sparse appresso-pilosis, supra eglandulosis; pedicellorum glandulis subsessilibus vel stipitatis non quaterlongioribus quam glandulis.—Type, in Herb. Univ. Wis.: roadcuts along U. S. 30, Sideling Hill, Pa.,

[3] Millspaugh, Bull. W. Va. Exper. Stat. 2: 355. 1892.
[4] Rydberg in Britton, Manual, p. 495. 1901.

July 11, 1940, *Fassett 20817*. The illustration of *R. parviflorus* var. *scopulorum*, in Rhodora, vol. 37, pl. 365, fig. 5, might well serve also as an illustration for *R. odoratus* f. *scopulorum*.

R. ODORATUS f. **parahypomalacus**, n.f., f. *hypomalacum* simulans, sed venis subtus glandulis 1–2 (–3) mm. longis.—TYPE, in Herb. Univ. Wis.: woods and cut-over land, foot of Shenandoah Mt., east of Franklin, W. Va., July 12, 1940, *Fassett 20823*.

R. ODORATUS f. **paraheteradenius**, n.f., f. *heteradenium* simulans, sed venis subtus glandulis 1–2(–3) mm. longis.—TYPE, in Herb. Univ. Wis.: along roadside, from halfway down to base of steep slope, associated with *Tsuga canadensis*, Guthrie Creek, about 2 miles east of Leesville, Ind., July, 1939, *R. M. Kreibel, C. F. McGraw & Morris Reeves*.

These forms may be keyed as follows:

a. Pedicels with glands on stalks mostly 0.5 mm. or more long, the stalks more than 4 times as long as the gland
  b. Stalks of glands on pedicels mostly more than 1 mm. long
    c. Veins on lower leaf-surfaces with glands whose stalks are 0.2–1.0 mm. long
      d. Leaves without dark-stalked glands on the upper surface, glabrous or lightly appressed-pubescent beneath.....f. *heteradenius*
      d. Leaves with dark-stalked glands on the upper surface, more or less velvety beneath.....f. *hypomalacus*
    c. Veins on lower leaf-surfaces with glands whose stalks are 1–2 (–3) mm. long
      e. Leaves glabrous or glabrate or lightly appressed-pubscent beneath .....f. *paraheteradenius*
      e. Leaves velvety beneath.....f. *parahypomalacus*
  b. Stalks of glands on pedicels mostly 1 mm. or less long
      f. Leaves with dark-stalked glands on the upper surface, more or less velvety beneath.....f. *bifarius*
      f. Leaves without dark-stalked glands on the upper surface, glabrous or glabrate or lightly appressed-pubescent beneath ....f. *glabrifolius*
a. Pedicels with glands subsessile or on stalks less than 0.5 mm. long and less than 4 times as long as the gland.....f. *scopulorum*

3. GEOGRAPHIC OCCURRENCE OF EACH FORM IN MASS COLLECTIONS

The object of this paper is not primarily to describe seven forms, or to point out the similarity of variation within *R. odoratus* to that within *R. parviflorus*. It is rather to study statistically the occurrence throughout the range of *R. odoratus* of each character used in the above key, and to determine what, if any, correlation there may be between the occurrence of these characters and the late geological history of the species.

For this purpose specimens have been taken from as many individuals as possible in each colony of the species which the writer has seen in the past three years; similar collections have also been made by several friends whose names appear in table I. The location of each mass collection is shown by a slanted figure on maps 1 and 2. It will be noted that in each state or province the numbers start anew. Table I gives the collection data for each collection, and table II the constituent forms of each.

TABLE I

Maine: *1.* Vassalboro, Aug. 16, 1939, *20781.*[5] *2.* Augusta, Aug. 14, 1939, *20782.* *3.* Paris, Aug. 8, 1939, *20783.* Vermont: *1.* Colchester, Aug. 7, 1939, *20785.* *2.*[6] Burlington, Aug. 7, 1939, *20786.* *3.* Wilmington Mountain, Bennington, Aug. 4, 1938, *20787.* *4.* Wilmington Mountain, Bennington, Aug. 4, 1938, *20788.* Massachusetts: *1.* Near Cold River, east slope of Mohawk Trail, June 25, 1940, *20789.* *2.* West slope of Mohawk Trail below Hairpin Turn, June 25, 1940, *20790.* Ontario: *1.* West of Brockville, Aug. 7, 1939, *20791.* New York: *1.* Westfall Road, Penfield Township, Monroe Co., June 30, 1940, *R. E. Shanks.* *2.* Atlantic Avenue, Penfield Township, June 30, 1940, *Shanks.* *3.* Eaton Road, Irondequoit, Monroe Co., July 14, 1940, *Shanks.* *4.* Pellett Road, Webster Township, Monroe Co., June 30, 1940, *Shanks.* *5.* Watervliet, June 24, 1940, *20792.* *6.* Duanesburg, June 24, 1940, *20793.* *7.* Schenevus, June 24, 1940, *20794.* *8.* Chenango Bridge, June 24, 1940, *20795.* *9.* Woodhull, June 23, 1940, *20796.* *10.* Greenwood, June 23, 1940, *20797.* *11.* Bolivar, June 23, 1940, *20798.* *12.* North side of Allegheny River, 4 miles north of Limestone, June 23, 1940, *20799.* *13.* Three miles north of Limestone, June 23, 1940, *20800.* *14.* About a mile south of the Lake, Allegany State Park, June 21, 1940, *20801.* *15.* Quaker Bridge, June 21, 1940, *20802.* *16.* Allegany State Park, 5 miles west of Limestone, June 23, 1940, *20803.* *17.* Peekskill, July 10, 1940, *20804.* *18.* U. S. 6 east of Bear Mountain Bridge, July 10, 1940, *20805.* *19.* U. S. 6 west of Bear Mountain Bridge, July 10, 1940, *20806.* *20.* West Haverstraw, July 14, 1940, *20807.* *21.* Chester, July 10, 1940, *20808.* Pennsylvania: *1.* Southeast of Mauch Chunk, July 10, 1940, *20809.* *2.* Northwest of Mauch Chunk, July 10, 1940, *20810.* *3.* Easton, July 14, 1940, *20811.* *4.* Ravine, July 11, 1940, *20812.* *5.* Ravine, July 11, 1940, *20813.* *6.* Muir, July 11, 1940, *20814.* *7.* Water Street, Sept. 18, 1939, *20815.* *8.* Along U. S. 30, Tuscarora Hill, July 11, 1940, *20816.* *9.* Along U. S. 30, Sideling Hill, July 11, 1940, *20817.* *10.* Laughlintown, Aug. 28, 1940, *20818.* *11.* Ten miles west of Erie, June 20, 1940, *20819.* Maryland: *1.* Rawlings, July 12, 1940, *20820.* West Virginia: *1.* Romney, July 12, 1940, *20821.* *2.* Old Fields, July 12, 1940, *20822.* *3.* Franklin, July 12, 1940, *20823.* Indiana: *1.* Jackson Co., about 2 miles east of Leesville, July, 1939, *R. M. Kreibel, C. F. McGraw & Morris Reeves.* *2.* Back Creek, 1–1½ miles west of Leesville, July, 1940, *Kreibel, McGraw & Reeves.*

---

[5] When a number is given without collector's name the writer was the collector.

[6] A number not shown on maps 1 & 2 represents a station close to the preceding number.

TABLE II

OCCURRENCE IN EACH COLLECTION OF THE FORMS OF *R. ODORATUS*

	hypomalacus	*heterademius*	*parahypomalacus*	*paraheterademius*	*bifarius*	*glabrifolius*	*scopulorum*
MAINE *1*		1			2	20	
2	10	5			6	4	
3	3	5			4		
VERMONT *1*	7	7			1		
2	4	9				4	
3	7	11			1	9	
4	3	5			7	5	
MASSACHUSETTS *1*	5	9					
2		11			1	3	
ONTARIO *1*	1				5	8	
NEW YORK *1*	3	28	2	8	2	8	
2		8		1			
3	4	8		3		1	
4	2	2				2	
5		15					
6	8	9			1	3	
7	14	7					
8		18		1	4		1
9	5	13	1				
10	2	23	1				
11	10	2			4	1	
12	8	6					
13		7	1				
14	4	10					
15	10	11					
16	4	4					
17	28	35	1		1	1	
18	7	1	1		1		
19	23	4	3		11	1	
20	8	4			3	6	
21	6	7			5	2	
PENNSYLVANIA *1*	1	2			1	4	
2		4				2	
3	3	21			1	8	
4	9						
5	29				10	3	
6	4	2			6	1	
7	11				8		
8	4				7		
9	13	11			5	6	1
10	18	8	1		4	2	
11	25	14	2		3	2	
MARYLAND *1*	21	18			4	4	
WEST VIRGINIA *1*	19	7			3		
2	4	2					
3	79	5	3		10	7	
INDIANA *1*		22		30			
2		7		11			

4. CORRELATION OF VARIATION WITH GEOGRAPHY

Cursory examination of table II shows but one fact, namely, that 4 of the forms occur essentially throughout the range of the species (as far as represented in these collections—see map 12), and 3 are more local. But from this list certain data may be derived; some of these data are shown on maps 1 and 2. Map 1 shows the percentage in each collection of individuals with leaves glabrous or glabrate beneath (or lacking glands above). For example, in collection *2* from Maine, a total of 25 individuals shows 4 f. *glabrifolius*, and 5 f. *heteradenius*, a total of 9 glabrous individuals, or 36 per cent—accordingly, the figure 36 appears next to the *2* in Maine. Similarly, collection *3* from New York has, in a total of 16 individuals, 1 f. *glabrifolius*, 8 f. *heteradenius*, and 3 *paraheteradenius*, making a total of 12 glabrous individuals, or 75 per cent—the figure appears near the *1* in New York, since collections *1–4* are too close together to be mapped separately.

How significant are the percentages shown on map 1? Probably not very significant individually, for the following reasons. First, the numbers in each collection are small, mostly below 50, sometimes less than 25. Second, *R. odoratus* spreads by underground stems, and more than one collection may be made from one individual (*i.e.*, clone). This has been avoided as far as possible by taking specimens at some distance from one another or from isolated plants.

When the figures from many collections are totaled, they become statistically more reliable. From Maine, 60 individuals have been collected, from Vermont 80, Massachusetts 29, Ontario 14, New York 448, Pennsylvania 256, Maryland 47, West Virginia 139, and Indiana 70. These represent many times the number of individuals ordinarily examined in the taxonomic treatment of a group, where a single sheet from a region is often taken to represent THE PLANT OF THAT REGION.

In determining the significance of figures from one patch of Flowering Raspberry, and the significance of those from a general region, the ecology of the species must be taken into consideration. Its favorite habitat is recently cut soil; it is

sometimes found on a river-cut bank, which may be more or less wooded, but its most frequent occurrence is along road-cuts. Nearly all of its stations are, therefore, more or less recent, the road-cuts being more recent than the river-cuts. But although any patch may be recent (and temporary) the species may be nevertheless of ancient occurrence in the region as a whole.

There is another important point regarding individual patches of *R. odoratus*—the seeds are, presumably, spread by birds, and the syncarp may contain seeds of different genetic constitutions (due to heterozygosity in the mother plant, and the possibility of pollen coming from several sources), and a colony may perhaps be started from a number of seeds dropped at one time; the variation within any patch should then be determined partly by the number of seeds originally dropped. If a colony increases in size vegetatively its original genetic constitution will tend to be preserved, while expansion by seeds will increase the number of forms. Again, the constitution of the species throughout a region stands as more significant than in any single patch.

With these facts in mind, map 1 may again be examined. It becomes evident that, in spite of lack of uniformity in many regions, the higher proportions of plants with glabrous leaves occur mostly toward the northern part of the range (omitting Indiana, for the present, as a more remote region). To emphasize this, we may divide the map into zones from north to south, by the broken lines running east and west. Within each of these zones the percentage of glabrous-leaved plants is determined (by totaling the figures from all the collections, not by averaging the percentages of each), with the result shown by the large figures along the right-hand margin of the map. There appears an unmistakable trend toward the appearance of velvety leaves southward and of glabrous leaves northward.[7] With consideration of the line of farthest advance of

[7] Perhaps it should be restated at this point that by "glabrous leaves" is meant also the glabrate or somewhat pilose leaves lacking glands on the upper surface, and by "velvety leaves" is meant those which tend to be more pubescent beneath and have dark glands above; cf. the key (page 303) and the discussion on page 301.

Pleistocene glaciation (line of crosses on map 10) a definite correlation appears. If it is assumed that *R. odoratus* survived glaciation south of the glaciated regions and migrated northward after the disappearance of the ice[8] it becomes evident that the species became more glabrous as it spread northward. This has not involved the origin *en route* of a new character, for glabrous plants occur in the extreme southern part of the range (represented in the Gray Herbarium by sheets from Virginia, North Carolina, Kentucky and Tennessee) and velvety leaves occur in the extreme northern part of the range (specimens in the Gray Herbarium from Quebec and Nova Scotia), but rather a change in the proportion of occurrence of the character. Is this because (1) the glabrous plants are more suited, physiologically, to the northern regions, (2) the glabrous plants were for some reason more vigorous in spreading, or (3) simply that as the species migrated chance happened to favor partial elimination of pubescent individuals?

The situation regarding pubescence of leaves in *R. odoratus* is just the reverse of that regarding the pubescence of the stem in the Red Raspberry *(Rubus idaeus,* or *R. strigosus).* In the latter, the proportion of pubescent plants increases northward. Perhaps any purpose that may be ascribed to a hairy covering is of less effect than is the linkage of pubescence, or in other cases glabrousness, with other characters which have a closer relation to the environment.

Similar progressive variation has been demonstrated for the snail, *Partula suturalis,* in the isolated valleys on the island of Moorea.[9] Eastward, colonies are composed entirely of dextral individuals, and these gradually give way, westward and northwestward, to colonies composed entirely of sinistral individuals (see map 11).

On map 2 are plotted the percentages of individuals in each colony with short glands on the pedicels (f. *bifarius* and f. *glabrifolius).* As on map 1, there is lack of uniformity from local-

[8] This does not preclude the possibility of interglacial migration also.

[9] Crampton, H. E. Studies on the variation, distribution, and evolution of the genus *Partula:* the species inhabiting Moorea. Carnegie Institution of Washington. Publ. 410. 1932.

ity to locality, but here, again, appear decided tendencies: the group of low figures in New York, for example, is striking. The series is not as definite from north to south as it was on map 1, but by grouping the localities as is shown by the broken lines on map 2 there can be demonstrated a fair uniformity within regions and great variation between regions. The tendency is not all in one direction as it was in pubescence of leaves. Starting with a low percentage (17) in the south, we find a rise as we go northeastward, a drop in the central region, and a sharp rise in the northern part. These facts favor the third hypothesis suggested above, namely, that as the species migrated there were slight changes in the frequencies of the characters due to chance or to unknown factors; with reference to pubescence of leaves all the changes were in the same direction, and with reference to the glands of the pedicels they were in different directions in different regions.

Two other characters appear in the key on page 303. One of these is the presence of subsessile glands instead of definitely stalked glands on the pedicels. Only two individuals have been seen with this character, one from Chenango Bridge (New York no. *8*) and the other from Sideling Hill (Pennsylvania no. *9*). This small occurrence is of little significance except for comparison with the situation in *R. parviflorus*, where in the plant of the Great Lakes such subsessile glands are found on only about 1 per cent of the plants (26 out of 2191 individuals collected), but in the western range of the species occur in much larger numbers (68 of 109 plants from the Black Hills of South Dakota, 98 of 242 plants from Montana, Wyoming and Utah, and 71 of 123 plants from Colorado). The remaining character used in the key lies in the stalked glands on the lower surface of the veins; ordinarily these do not exceed 1 mm., but on a majority of the plants from Indiana and from a very few elsewhere are hairs 1–2 mm. or more long. The occurrence of this character in large proportions only in the unglaciated part of Indiana is important, for it indicates a much more ancient migration from the Alleghenian center to Indiana than to New York and New England. Previous to the more recent glacia-

tions, at least, *R. odoratus* migrated westward, perhaps changing the frequency of some characters as it migrated. Either because of these changes or because of isolation as small populations[10] in the southern Alleghenies and in Indiana the plants of these two regions became different: the eastern plants became predominantly velvety-leaved and those of Indiana entirely glabrous-leaved; in the East the presence of glands on the upper leaf-surfaces became generally associated with velvety lower surfaces while in Indiana they appeared freely associating with nearly glabrous lower surfaces; the eastern plants retained short glands on the pedicels in many cases while those of Indiana eliminated this character and retained only long glands; and, finally, the majority of plants of Indiana retained long glands on the veins of the lower leaf-surfaces, while only a small minority of eastern plants showed this character. Available material is insufficient for further study of this phase of migration and isolation (see map 12 for an indication of the proportion of the range of the species represented by mass collections), but collections from Virginia to Indiana and southward should yield interesting evidence.

It is now possible to combine data concerning all the characters discussed above, to discover closeness of relationship of plants in different regions. For this purpose, localities whose populations show the closest resemblance, all characters considered, have been grouped into regions. For example, collections *1–4* in New York, in the vicinity of Rochester (Station New York *1* on maps 1 & 2), agree in having a rather high percentage of glabrous leaves (86, 100, 75, 66, on map 1) and a rather low percentage of short-glanded pedicels (20, 0, 6, 33, on map 2). These four collections are thus treated as one regional unit, labelled "Rochester" on map 3. Localities *7* and *8* in Pennsylvania are in close agreement (both 0 for glabrous leaves, 42 and 64 respectively for short glands) and so are grouped together. The resulting regional groupings are shown on map 3, where each region is vertically shaded and labelled with a name. These regions appear to show little or no relation to physiographic features.

[10] Compare Dobzhansky, Genetics and the origin of species, pp. 118–148. 1937.

The comparative values of figures from each region may be judged from the figure in parentheses just below each regional name on map 3, which indicates the number of individuals collected in that region. The numbers from Ontario and Mauch Chunk (Pennsylvania *1* and *2)* are each only 14, so small that these regions are omitted from the map. On map 3 are also recorded the percentages for each of the four characters in which the plants vary, obtained by totaling and averaging for all the plants in each region; these percentages are combined into a pie-diagram for each region. For example, among the 60 plants from Maine there were 24 of f. *glabrifolius* and 11 of f. *heteradenius*, a total of 35 plants with leaves not velvety beneath, or 58 per cent; this is indicated on map 3 by a 58 placed in the upper quadrant of the pie-diagram for the Maine region. There were 24 f. *glabrifolius* and 12 f. *bifarius* to total 36 individuals with short glands on the pedicels, or 60 per cent; this is indicated by a 60 in the left quadrant in the pie-diagram. Subsessile glands on the pedicels, and long-stalked glands on the leaves below, are not represented in Maine, and this is indicated by zeros placed, respectively, in the lower and in the right quadrants.

In the pie-diagrams on map 3, figures of 100 or 0 indicate uniformity in the characters concerned, while figures approaching 50 indicate that the plants of the region are variable in the characters concerned.

From the figures on map 3 may be calculated the average of percentage differences between any two regions. To compare, for example, Maine with northern Vermont: velvety and glandular leaves *vs.* non-velvety and non-glandular leaves, shows a difference of 5 (63 per cent minus 58 per cent), long glands on the pedicels *vs.* short glands shows a difference of 44 (60 per cent minus 16 per cent), and there is no difference in the other two characters. The average of percentage differences (5 plus 44 plus zero plus zero, divided by 4) is 12. A comparison of Maine with Indiana, however, gives a much higher figure, adding 42 (100 minus 58), 60 (60 minus 0), 0 (0 minus 0), and 59 (59 minus 0), to average 40.

Table III shows in tabular form the averages of percentage

differences between all regions. From it may be made a number of correlations with the assumed post-glacial history of the species; these become more obvious when the data are transferred to maps.

TABLE III

AVERAGES OF DIFFERENCES OF PERCENTAGES BETWEEN REGIONS

	Maine	Northern Vermont	Rochester	Susquehanna	Western New York	Allegany	Erie	Bear Mt.	Easton	Schuylkill	Tuscarora	Potomac	Indiana
Maine	—	12	23	13	11	16	19	16	16	19	17	19	40
Northern Vermont	12	—	10	3	4	6	9	8	9	17	24	10	28
Rochester	23	10	—	11	13	15	18	17	7	28	35	19	18
Susquehanna	13	3	11	—	7	9	12	9	7	18	25	11	28
Western New York	11	4	13	7	—	3	7	8	13	19	26	11	27
Allegany	16	6	15	9	3	—	9	10	15	20	27	12	25
Erie	19	9	18	12	7	9	—	3	18	13	20	4	33
Bear Mt.	16	8	17	9	8	10	3	—	15	11	18	3	34
Easton	16	9	7	7	13	15	18	15	—	21	28	18	25
Schuylkill	19	17	28	18	19	20	13	11	21	—	7	9	45
Tuscarora	17	24	35	25	26	27	20	18	28	7	—	16	52
Potomac	19	10	19	11	11	12	4	3	18	9	16	—	37
Indiana	40	28	18	28	27	25	33	34	25	45	52	37	—

In general, regions which are close to each other show closer relationship than do regions more distant from each other; this is to be expected in a freely interbreeding population spread over a large area. But certain irregularities in this general pattern will appear in a species whose range has comparatively recently been altered by such an event as glaciation. This is brought out in map 4, which shows the close interrelationship of the regions across northwestern Pennsylvania, southern New York, and western New England (recently glaciated areas[11]), fairly close interrelationship among the pre-Wisconsin regions from central Pennsylvania southward, but rather distant interrelationship between the pre-Wisconsin regions and the post-Wisconsin regions. This is brought out further in map 5 which shows only the more closely related regions.

[11] The Allegany region was not actually glaciated, but was a tongue of unglaciated territory only 10 miles across and was probably untenable for *R. odoratus* during glaciation.

The Potomac region (map 6) and the Easton region (map 7) show relationship closer to most post-Wisconsin regions than to the much nearer pre-Wisconsin regions. This may be because the pre-Wisconsin stations have been isolated for a long time. Their close relationship with post-Wisconsin regions may indicate that much of the population of these regions was derived from the Potomac and the Easton regions. Furthermore, it seems to be more than a coincidence that in each general direction from the Potomac region, there is some correlation between geographic distance and distance of relationship—this is shown on map 6 by the sets of parallel lines emerging from the Potomac region. The Easton region is similar to the Potomac region in this respect.[12] The relation of each of these regions to other pre-Wisconsin regions is generally more remote than to the post-Wisconsin regions, and shows no correlation with geographic distance.

The relationships between the Tuscarora region and the other regions (map 8), and between the Schuylkill region and the other regions (map 9), show no correlation with distance. These regions are in general less closely related to the post-Wisconsin regions than are the Potomac region and the Easton region. Perhaps, then, there was greater contribution to the post-Wisconsin populations of the glaciated regions from the Potomac region and the Easton region than there was from Tuscarora region and the Schuylkill region. It must be borne in mind that other regions, not sampled in this study, might throw more light on this phase of the subject.

The relation of the Indiana region to all other regions is distant, and shows little or no correlation between geographic distance and relationship (map 10). This is compatible with the assumption that the isolation of *R. odoratus* in unglaciated southern Indiana greatly antedates the postglacial migration of that species into New York and New England.

It is conceivable that with full collections from every point in the range of the species, a map could be constructed along

[12] The Easton region was covered by the older ice sheets but not by the Wisconsin. Since the Easton region is represented in this study by a collection from but one locality, its figures are probably of less value than those from a region like Potomac with its six collections.

the lines of map 5, which would actually show the course of postglacial migration. How far map 5 falls short of representing the full facts may be judged from map 12, which shows the amount of coverage of the range of *R. odoratus* by the available mass collections.

II. Variation in *R. parviflorus*

1. THE KINDS OF VARIATION

The more conspicuous variations within *R. parviflorus* are of the following ten types. On most of these characters, subdivisions of the species have, by one taxonomist or another, been proposed. To judge from the literature, no attempt has previously been made to assemble from each region a large amount of material for the purpose of determining just how many subdivisions of the species might grow together. This discussion is based primarily on 104 such collections totaling 2137 individuals; the proportion of the range thus covered may be judged by comparing map 24, which shows the known range of *R. parviflorus*, with map 19, showing the locations of mass collections. Material of the species in the Gray Herbarium, the New York Botanical Garden, the University of California, Pomona College, and the University of Wisconsin has also been studied.

1. Calyx villous or not villous. Individuals with villous calyces appear throughout a large part of the range of the species, always in company with a great majority of plants with the calyces not villous. Encountering villous calyces only in plants from the Great Lakes region in what he called var. *genuinus* and in var. *velutinus* from the Coast Ranges of California, Professor Fernald stated (*l. c.*, page 275) that these two varieties were closely related. When examined in the light of subsequent collections, which show villous calyces to occur throughout the range of the species, they seem to represent rather a sporadic variation, present in about a third of the plants from the Coast Ranges and a much smaller proportion of individuals from the rest of the range. In maps 20 and 21 the percentage of plants in each region with villous calyces is shown by the figure in the lowermost sector of each pie-diagram. Map 13 shows the occurrence of plants with villous calyces, except in California.

2. Glands or setae of the pedicels. These are of four types. (1) The glands may be on stalks about 0.5 mm. long. (2) The glands may be on stalks reaching 1–2 mm. in length, or rarely even longer. There seems to be no correlation of gland color with length of the stalk. (3) The glands may be sessile or on stalks less than one-fourth as long as the diameter of the gland, or rarely the glands may be entirely absent. (4) There may be, instead of glands, broad-based setae; this type is very rare, having been observed in only two collections. Types 1–3 occur practically throughout the range of the species, and in combination with any of the other characters. The occurrence of glands about 0.5 mm. long is shown on maps 13, 16, and 17; the occurrence of glands 1 mm. or more long is shown on maps 14 and 15; the occurrence of subsessile glands is shown on map 18. In addition to the ranges shown on these maps, types 1–3 also are found in the Coast Ranges of California. Types 1–3 are not always clear-cut, and may grade into each other.

3. Leaves velvety beneath or not velvety beneath. Lower leaf-surfaces grade from perfectly glabrous, through a condition where scattered appressed hairs are present, to densely velvety. Some of the intermediates make it difficult to maintain two categories. In the present study, those leaves which feel velvety to the touch are treated as such. Throughout most of the range of the species velvety leaves show little or no correlation with other characters; they are not common on plants with sessile glands on the pedicels, but such a combination occasionally occurs, particularly in California. In the Great Lakes region 1093 out of 1346 individuals examined had velvety leaves; in the Coast Ranges velvety leaves are the rule almost without exception, being present on all but one of the 327 individuals examined; in the intermediate region they are in the minority, occurring in 231 out of 660 plants examined. Maps 14 and 16 show the occurrence of velvety leaves, and maps 13, 15 and 17 show the occurrence of glabrous or subglabrous ones.

4. Petioles with minute puberulence beneath the glands, or without such puberulence. When studied in the Gray Herbarium by the writer, this character appeared to be of some importance, for, while common in the western states, puberulent petioles appeared only on one sheet from the Middle West, and this was from Keweenaw Point, Michigan, where a number of far western plants are known to occur. But examination of the mass collections made about the Great Lakes showed plants with puberulent petioles from throughout the entire range. Its complete lack of taxonomic value in this region is shown by the fact

that the leaves on the upper part of a stem may have puberulent petioles while the leaves farther down may have the petioles glabrous beneath the glands. It was just coincidence that the only sheet in the Gray Herbarium from the Middle West, showing puberulent petioles, was from Keweenaw Point. One thing about this character may be significant, however; while the puberulence of the petioles appears to be, for the most part, a response to exposure, nevertheless nearly all the plants from the Coast Ranges of California have all their petioles puberulent. The exceptions are in a collection from Eureka (*Gillespie 15398*, described in tables V, VI & VII, pages 329, 332, 333), in which there is great variation. Most of the individuals have the stem and petioles copiously villous (character no. 6), as var. *velutinus*, some do not, and a few are intermediate. Some have the petioles puberulent and others do not. That this is not entirely due to habitat was demonstrated by growing the offspring of a few of these plants in the greenhouse at the University of Wisconsin. Plants grown from different seeds in one syncarp, under identical conditions in the greenhouse, showed the same variations that were present in the original collection.

5. Pedicels villous or not villous. Of the 248 individuals in the mass collections from the Coast Ranges of California, all but 42 are characterized by the presence of spreading hairs exceeding the glands on the pedicels. Of nearly 2000 individuals from the rest of the range of *R. parviflorus* only 3 have villous pedicels: two are from Wisconsin and one from southern California.

A collection from the District of Renfrew, Vancouver Island, *C. O. Rosendahl & Carl J. Brand, 3*, also has long hairs on the pedicels. This collection has been seen in the Herbarium of the University of California. The same collection, as it appears in the Herbarium of Pomona College, shows this characteristic to a lesser degree, and is probably from a different clone.

6. Stem, stipules and petioles villous or not villous. Plants of the Coast Ranges nearly always have these organs more or less villous (rarely sparsely so), and so are separated as var. *velutinus*, as distinguished from the rest of the species which lacks this character. For the correlation of this character with others see the discussion of var. *velutinus*, on page 318.

7. Cutting of leaves. *R. nutkanus* f. *lacera* Kuntze, [13] or *R. parviflorus* var. *bifarius* f. *lacera* Fernald,[14] has leaves cleft ⅔–¾ to the base, and *R. parviflorus* f. *pedatifidus* Hermann[15] has them cleft entirely to the base.

[13] Meth. Sp. 102. 1879.

[14] Rhodora **37**: 281. 1935.

[15] Rhodora **37**: 61, *pl. 326, fig. 2*. 1935.

8. Cutting of sepals and petals. *R. parviflorus* var. *Fraserianus* J. K. Henry,[16] or *R. parviflorus* var. *bifarius* f. *Fraserianus* Fernald,[14] has the petals laciniate-dentate at summit, and a sheet from the Santa Cruz Mountains of California has the calyx-lobes laciniate.

9. Color of petals. The petals, white in most plants, are recorded on the labels as turning pink with age on sheets from Del Norte County, California, and from Mt. Hamilton, Washington.

10. Size of flowers. This varies considerably from clone to clone, but there seems to be no justification for the division into a larger-flowered western variety and smaller-flowered variety about the Great Lakes, such as has been proposed by Torrey & Gray[17] and by Farwell.[18] The smallest-flowered plants seen by the writer comprise a collection of 21 individuals from Tuolumne County, California *(Wiggins 9245,* described as California *1* in tables v and vi, pages 329 and 332) ; the flowers are about 2.5 cm. in diameter, with a calyx sometimes as little as 12 mm. in diameter. This small-flowered extreme may be identified, by the latest taxonomic treatment of the *R. parviflorus* group,[19] as "var. *grandiflorus.*"

It is evident that here are variations of several series. Groups 7, 8, 9 and 10 include sporadic anomalies of rare occurrence, apparently occurring anywhere throughout the range of the species without relation to each other or to the other series of variations. Groups 1–6 are concerned with pubescence. Groups 1, 2 and 3 have been used by Professor Fernald to distinguish varieties; an appraisal of these varieties in the light of new and more ample material follows.

2. THE "VARIETIES" OF *R. parviflorus*

1. *R. parviflorus* var. *genuinus* Fernald, Rhodora 37: 277. 1935. This is distinguished by its villous calyx and is said to be confined to the region of the upper Great Lakes; the present writer has collected it from a much wider range (map 13). The case against var. *genuinus,* as defined by Fernald, lies in the fact that its main character, a villous calyx, may appear anywhere throughout the range of the species, in various combinations with other characters, for plants with villous calyx may have pedicels with long glands (like vars. *hypomalacus* and *heteradenius),* or short glands (like vars. *bifarius* and *grandiflorus),* or subsessile glands (like vars. *scopulorum* and *parvifolius);* the leaves may be glabrous or glabrate beneath (like vars. *heteradenius* and *grandiflorus)* or soft-pubescent (like vars. *hypomalacus* and *bifarius).*

[16] Torreya **18:** 54, *fig. 1.* 1918.
[17] Fl. N. Am. **1:** 450. 1840.
[18] Am. Midl. Nat. **11:** 281. 1929.
[19] Rhodora **37:** 276. 1935.

2. *R. parviflorus* var. *velutinus* (Hook. & Arn.) Greene, as defined by Fernald, *l. c.*, is distinguished from vars. *hypomalacus* and *bifarius* only by its villous calyx. But all individuals of these so-called varieties, as they occur in the Coast Ranges (to which region, as Fernald correctly states, var. *velutinus* is confined), are characterized by having long spreading hairs on the nodal regions, often the internodes, and the petioles, and by strigose stipules; these characteristics do not occur elsewhere in the range of *R. parviflorus*. In other words, the plants of the Coast Ranges may or may not have the calyx villous and may have the glands of the pedicels long or short, but they are set off from the rest of the species by the pubescence of the nodes, petioles and stipules. Var. *velutinus*, as redefined on the basis of this character, also differs in tendencies from the rest of the species as follows: in var. *velutinus* 83 per cent of the individuals in the mass collections have long hairs on the pedicels, 33 per cent have villous calyces, and 100 per cent have leaves velvety beneath, whereas in the rest of the range of *R. parviflorus* only 0.0015 per cent of the individuals have long hairs on the pedicels, 0.019 per cent have villous calyces, and about 64 per cent have leaves velvety beneath. These facts are brought out visually in map 20, where the pattern of the pie-diagram for the Coast Ranges is conspicuously different from all the others. Var. *velutinus* is therefore retained as a valid geographic variety, but on different characters, in part, from those relied on by Professor Fernald.

3. *R. parviflorus* var. *hypomalacus* Fernald, *l. c.*, p. 277, (4) var. *heteradenius* Fernald, *l. c.*, p. 279, (5) var. *bifarius* Fernald, *l. c.*, p. 280, and (6) var. *grandiflorus* Farwell, as redefined by Fernald, *l. c.*, p. 281. The 2 characters of long glands *vs.* short glands on the pedicels, and leaves velvety beneath *vs.* leaves glabrous to glabrate beneath, occur in 4 combinations to make these 4 varieties. Their ranges as published by Professor Fernald (dots on maps 14–17 in this paper) are rather similar, the only significant departure from the general pattern being that var. *grandiflorus* alone occurs in South Dakota, southern Montana, Wyoming, Utah and Idaho. Even this amount of geographic segregation seems to break down with other collections, as shown by the x's on these same maps. Moreover there is very little segregation of these "varieties" in the field. Of 8 mass collections from Minnesota, 2 collections had 4 of these "varieties," 2 had 3 "varieties," 3 had 2 "varieties," and 1 had 1 "variety." This statement refers only to the 4 "varieties" whose names head this paragraph; in many cases others were also present. Of 6 mass collections from northern Wisconsin, 1 had 4 "varieties," 3 had 3 "varieties," 1 had 2 "varieties,"

and 1 had 1 "variety." Such cases might be cited indefinitely, but the mass collections are described in tables VI & VII.

As stated in the discussion of that variety, the var. *genuinus* of Fernald breaks up on just the characters used by him to define vars. *hypomalacus, heteradenius, bifarius* and *grandiflorus.* Var. *velutinus,* as defined by Fernald, has subdivisions equivalent to vars. *hypomalacus* and *bifarius.* Var. *scopulorum* has a phase with velvety leaves and a phase with glabrous or glabrate leaves.

It is concluded, then, that in the absence of segregation of vars. *hypomalacus, heteradenius, bifarius* and *grandiflorus* on basis of geographic distribution, habitat, or locality, they represent forms only.

7. *R. parviflorus* var. *scopulorum* (Greene) Fernald, and (8) var. *parvifolius* (Gray) Fernald. These are distinguished from each other by the height of the plant, the width and pubescence of the leaves, the number of flowers in the inflorescence, and the length of the lowest pedicel. These distinctions do not hold in the field. Two collections in the gorge of Fish Creek Falls, Steamboat Springs, Colorado (pl. 10, fig. 4), consisted of some plants with sessile glands and others with stalked glands on the pedicels. The characters of those with sessile glands may be seen, in table IV, to make very difficult any separation into two groups such as have been named *scopulorum* and *parvifolius.*

These two so-called varieties with glands of the pedicel sessile or nearly so are recorded by Professor Fernald as occurring only from southern British Columbia, Oregon and Montana, southward to Arizona, New Mexico and northern Chihuahua. However, there are, in the herbaria of the University of California and of Pomona College, numerous specimens from California having the glands of the pedicels sessile or nearly so; they have leaves velvety beneath and cannot be placed by Fernald's key. The present writer has collected plants with sessile glands (always accompanied by others with stalked glands) in the Black Hills of South Dakota and in the three Great Lakes states where *R. parviflorus* is known. Map 18 shows the occurrence of plants with sessile or subsessile glands, as originally mapped by Fernald, and as demonstrated by other collections not seen by him.

The sessile or subsessile gland is not clear-cut from the stipitate gland; a distinction between them forms the primary division in Professor Fernald's key. Var. *scopulorum* (including var. *parvifolius)* with glabrous leaves grades into var. *grandiflorus,* and its unnamed relative with pubescent leaves grades into var. *bifarius.*

The case against vars. *scopulorum* and *parvifolius,* then, sums up as follows: the two are not distinct from each other in the field; they

TABLE IV

CHARACTERS OF VAR. *SCOPULORUM* AND VAR. *PARVIFOLIUS*, AND OF TWO MASS COLLECTIONS FROM FISH CREEK FALLS, STEAMBOAT SPRINGS, COLORADO

	scopulorum	*parvifolius*	Fish Creek Falls I	Fish Creek Falls II
Height of plant	1–2 m.	1.5–6.0 dm.	0.4–1.5 m.	
Width of leaves	1–3 dm.	0.5–1.3 dm.	1.2–2.4 dm.	1.0–1.9 dm.
Lower surface of leaves	Glabrous	Minutely and sparsely pubescent to glabrate	Glabrous to distinctly velvety	Glabrous to distinctly velvety
Number of flowers in inflorescence	3–7	1–2 (–4)	2 with 2 fl. 8 with 3 fl. 4 with 4 fl. 1 with 5 fl.	4 with 1 fl. 5 with 2 fl. 7 with 3 fl. 3 with 4 fl.
Length of lowest peduncle	1.0–3.5 cm.	2.0–6.0 cm.	1.5 cm. on 1 2.0 cm. on 3 2.5 cm. on 3 3.0 cm. on 2 3.5 cm. on 2 4.0 cm. on 6 4.5 cm. on 1 5.5 cm. on 1 6.0 cm. on 1	1.0 cm. on 1 2.0 cm. on 6 2.5 cm. on 1 3.0 cm. on 5 3.5 cm. on 3 4.0 cm. on 1 5.0 cm. on 1 6.0 cm. on 1

occur with and grade into vars. *grandiflorus* and *bifarius;* the subsessile gland is not correlated with a glabrous or glabrate leaf; they are not confined to any limited part of the range of the species, but may rather be found in the same patch with the other "varieties" almost (or perhaps quite) everywhere that *R. parviflorus* grows.

Mr. Joseph Ewan, of the University of Colorado, who has kindly read the manuscript of this paper, comments as follows on the disposition of var. *parvifolius:*

"In my opinion there is something valid about the thing isolated by Fernald, following earlier segregations, centering about New Mexico and Arizona. I have personally discovered, without any particular search in herbaria for them, several 'good' sheets of that entity. It is characterized by the concomitance of definitely smaller leaves than any other variety or subspecies of the species, with fewer flowers to an inflorescence, and a slender habit. I do not feel that *scopulorum* is more than a form, of indefinite lines at best, but this southern phase of the species deserves, I believe, recognition. . . . Your collection from Fish Creek Falls, Steamboat Springs, Colorado, illustrates a representative of the zone of overlap between var. *parvifolius* and f. *scopulorum*, if such a form is to be recognized, even demonstrating perhaps a hybrid swarm dating from a long time ago in the movements of this *Rubus*."

These comments are introduced so that botanists in the Southwest may have opportunity to observe and perhaps decide upon the validity of this small-leaved phase of the species. For the present, var. *parvifolius* is put into synonymy under f. *scopulorum* (page 323), and its revival would cause no nomenclatorial complication and require no new combination.

Here, then, is a set of characters appearing in different combinations, with any combination of characters being likely to occur anywhere in the range of the species. Such combinations of characters, lacking geographic ranges, are not usually treated as varieties, but as forms, if they indeed receive any nomenclatorial recognition.

Professor Fernald emphasizes[20] the "disconcerting but indisputable fact that these very differences in the distribution of glands in the inflorescence and of pilosity on the calices, branches and leaves or the absence of glands and pilosity from these areas, which mark the eight geographic segregates of *Rubus parviflorus*, are precisely the characters which are shuffled and reshuffled to add to the ever increasing score of 'species' of Blackberry (*Rubus* § *Eubatus*)! In *R. parviflorus* not even our most ardent advocates of specific segregation, who have felt competent to make generic segregates, have noticed them; nevertheless, they are quite as conspicuous in *R. parviflorus* as in segregates of *Rubus* § *Eubatus*, and if their phylogenetic importance is of equal value in the two sections, the Blackberries are eventually due for a pretty drastic realignment." The "if" in the last statement was commented upon by Professor Fernald, a few years ago,[21] in these very pertinent words: "As pure logic, wholly dissociated from the actual vagaries of Nature, this may be conceded; but, surely, when applied in classification, the logic often fails; characters which in one group are of great taxonomic importance in another may prove wholly unimportant and to be a series of nonconcomitant and unresolvable variables."

The taxonomic value of characters lies less in what they do in other groups, or in how conspicuous they may be, than in how they act. Pubescence of stem and peduncles is used as a

[20] Rhodora **37**: 274. 1935.

[21] Rhodora **35**: 165. 1933.

primary character in separating species of *Stellaria*,[22] is of varietal rank in *Ranunculus abortivus*, [23] and serves only to separate forms in *Oxalis europaea*.[24] Again in *O. europaea*, while differences in pubescence of stem and pedicels are used only to separate forms, the presence or absence of scattered hairs on the upper surface of leaflets differentiates varieties; this is not because pubescence of leaflet surface is more conspicuous or perhaps of greater importance to the plant, but because plants with such pubescence are found in different regions from those which lack it. This principle is summarized by Anderson[25] when he writes: "Particularly significant is the fact that the difference between *I. virginica* and *I. virginica* var. *Shrevei* is of about the same order of magnitude as the differences between colonies of *I. virginica* var. *Shrevei*. It would indeed be possible to find two swamps in the same township in southern Michigan whose iris populations have as great an average difference as that between *Iris virginica* of the Atlantic Coastal plain and *Iris virginica* var. *Shrevei*. But in this latter case the difference, slight though it is, characterizes a whole region and has superimposed upon it the varying pattern of colony differences in each region."

Summary: With the exception of var. *velutinus*, the varieties of *Rubus parviflorus* described by Professor Fernald appear invalid to the present writer, for the following reasons. (1) The entities are not confined to the ranges described by him, but each occurs nearly throughout the range of the species. (2) Rare is the colony that is composed of but one entity, and many colonies are composed of a mixture of as many as five entities. (3) There seems to be little or no association of characters one with another, since they may appear in almost any combination, many of these combinations being impossible to place in Fernald's key to varieties.

3. THE FORMS OF *R. parviflorus*

The advisability of giving a formal name to each recombination of certain pubescence characters may be debatable, and

[22] Gray's Man., ed. 7, p. 381. 1908.
[23] Fernald, Rhodora **40**: 417. 1938.
[24] Wiegand, Rhodora **27**: 135. 1925.
[25] Ann. Mo. Bot. Gard. **23**: 494. 1936.

a list of nearly a score of new names within one species is apt to make the taxonomist gasp.[26] The present writer is of the opinion that forms should be named if the naming of them will serve a purpose. A group is named so that "we may be understood when we wish to speak of it."[27] There is to be occasion to speak of these combinations of characters, to discuss the significance of the occurrence of each, and eventually to distribute material illustrative of them, and these procedures will be facilitated by the assignment of names to them.

The following were treated as varieties by Professor Fernald:

R. PARVIFLORUS f. **hypomalacus** (Fernald) n. comb. *R. parviflorus* var. *hypomalacus* Fernald, Rhodora **37**: 277. 1935.

R. PARVIFLORUS f. **heteradenius** (Fernald) n. comb. *R. parviflorus* var. *heteradenius* Fernald, *l. c.*, 279.

R. PARVIFLORUS f. **bifarius** (Fernald) n. comb. *R. parviflorus* var. *bifarius* Fernald, *l. c.*, 280.

R. PARVIFLORUS f. **glabrifolius,** n.f., foliis subtus glabris vel glabratis vel sparse appresso-pilosis; pedicellorum glandulis stipitatis 0.5–1.0 mm. longis; calycibus non villosis.—TYPE, in Herb. Univ. Wis.: small patch along roadside, 3.6 miles west of Meldrum Bay, Ontario, Aug. 5, 1939, *Fassett 20567*. *R. parviflorus* var. *grandiflorus* Fernald, *l. c.*, 281; perhaps *R. parviflorus* var. *grandiflora* Farwell, Am. Midl. Nat. **11**: 263. 1929.

R. PARVIFLORUS f. **scopulorum** (Greene) n. comb. *R. nutkanus* var. *scopulorum* Greene ex Focke, Bibl. Bot. **17**, pt. 72: 124. 1911. *R. parviflorus* var. *scopulorum* Fernald, *l. c.*, 283. *R. nutkanus* var. *parvifolius* Gray, Pl. Fendl., Mem. Am. Acad. II, **4**: 42. 1849. *R. parviflorus* var. *parvifolius* Fernald, *l. c.*, 284. In uniting these two varieties as one form, it seems advisable to use the name *scopulorum* rather than the one antedating it (in the varietal rank), which not only emphasizes a character not necessarily applicable to the plant but whose resemblance to the specific name is liable to invite confusion.

R. PARVIFLORUS f. **Nuttallii** (Torr. & Gr.) n. comb. *R. parviflorus* Nutt., Gen. **1**: 308. 1818. *R. nutkanus* β *Nuttallii* Torr. & Gr., Fl. N.

[26] "If one were to attempt to name *formae* in *Rubus* the result might be appalling. One may note minor variations but there is no necessity to give them Latin names or to restrict them to formal categories." L. H. Bailey, Gentes Herbarum **5**, Fasc. I. 19. 1941.

[27] The Vienna Rules of Nomenclature. Rhodora **9**: 36. 1907.

Am. 1: 450. 1840. *R. parviflorus* var. *genuinus* Fernald, *l. c.*, 277. The phrase in Nuttall's description, "segments of the calix villous," would seem to indicate the plant treated by Professor Fernald as var. *genuinus*, but the Nuttall specimen from Michilimackinak Island is the plant called by Fernald var. *grandiflorus*, and in this treatment f. *glabrifolius*. The name on the label is not preceded by an asterisk so its position as type is not secure, and the label bears the note "lost all but this fragment." Perhaps the villous calyx was observed by Nuttall on material subsequently lost. On the sheet with the Nuttall specimen are three others: one was collected by R. H. Kern in New Mexico; the second by Dr. Tiling in Sitka; and the third, without label, is definitely the var. *velutinus* of the Coast Ranges, having strongly villous calyces, and is mounted so that it partly overlies and partly underlies the Nuttall plant. Less confusion will be caused by following Nuttall's description, as Professor Fernald did, than by trying to redistribute names on the basis of this sheet.

The following forms are the results of other combinations of the characters used in the determination of varieties by Professor Fernald:

R. PARVIFLORUS f. **trichophorus,** n.f., f. *bifarium* simulans sed calycibus villosis. TYPE, in Herb. Univ. Wis.: Bark Point, Bayfield Co., Wis., July 10, 1938, *N. C. Fassett & J. T. Curtis 20545.*

R. PARVIFLORUS f. **villosus,** n.f., f. *hypomalacum* simulans sed calycibus villosis. TYPE, in Herb. Univ. Wis.: near head of Nigger Grade, Palomar Mt., San Diego Co., Calif., Aug. 4, 1938, *Frank F. Gander 6239.*

R. PARVIFLORUS f. **allocalyx,** n.f., f. *scopulorum* simulans, sed calycibus villosis. TYPE, in Herb. Univ. Wis.: 7 miles north of Savoy, S. D., June 26, 1939, *Fassett 20201.*

R. PARVIFLORUS f. **micradenius,** n.f., f. *scopulorum* simulans, sed foliis subtus velutinus. TYPE, in Herb. Univ. Wis.: gorge below Fish Creek Falls, Steamboat Springs, Colo., July 3, 1939, *Fassett 20193.*

A rare type of epidermal outgrowth on the pedicels, not accounted for in Professor Fernald's treatment, is a glandless flattened trichome 0.5–1.0 mm. long. This is associated with glabrous leaves in one case, and with velvety leaves in another.

R. PARVIFLORUS f. **adenius,** n.f., pedicellorum setis 0.5–1.0 mm. longis eglandulosis; foliis subtus subglabratis. TYPE, in Herb. Univ. Wis.: sand back of dunes, Whitefish Bay, Door Co., Wis., July 31, 1938, *Fassett 20211.*

R. PARVIFLORUS f. **acephalus,** n.f., f. *adenium* simulans sed foliis subtus subvelutinis. TYPE, in Herb. Univ. Wis.: Port Orford, Ore., Aug. 12, 1938, *Doris K. Gillespie 15399.*

R. parviflorus var. *velutinus,* confined to the Coast Ranges of California, shows variations just paralleling those in the rest of the species. In studying the fluctuations of var. *velutinus* the writer has had the advantage of the loan of the material from the herbaria of the University of California and of Pomona College, as well as the most generous mass collections made by Drs. Gillespie, Mathias, Schreiber, Constance and Wiggins. To keep clear the parallelism of forms, each one in var. *velutinus* is here given a name based on that of the corresponding form in the widespread phase of the species.

R. PARVIFLORUS var. VELUTINUS f. **parbifarius,** n.f., caulibus, petiolis, pedicellis pedunculisque villosis; foliis subtus velutinis; pedicellorum glandulis stipitatis 0.5–1.0 mm. longis. TYPE, in Herb. Univ. Wis.: north slope of Strawberry Creek Canyon, 0.7 miles above its mouth, 1100 ft. alt., Berkeley, Calif., Aug. 4, 1938, *L. Constance 2397.*

R. PARVIFLORUS var. VELUTINUS f. **praebifarius,** n.f., f. *parbifarium* simulans sed pedicellis non villosis. TYPE, in Herb. Univ. Wis.: Eureka, Calif., Aug. 6, 1938, *Doris K. Gillespie 15397.*

R. PARVIFLORUS var. VELUTINUS f. **paratrichophorus,** n.f., f. *parbifarium* simulans sed calycibus villosis. TYPE, in Herb. Univ. Wis.: under *Sequoia sempervirens,* ½–1 mile from the ocean, Palo Colorado Canyon, Santa Lucia Mts., about 12 miles south of Carmel, Calif., Aug. 7, 1938, *Mildred E. Mathias 1389.*

R. PARVIFLORUS var. VELUTINUS f. **parahypomalacus,** n.f., caulibus, petiolis, pedicellis, pedunculisque villosis; calycibus non villosis vel subvillosis ad basem; pedicellorum pedunculorumque glandulis stipitatis 1–2 mm. longis. TYPE, in Herb. Univ. Wis.: 1.5 miles southeast of Abbot's Lagoon, Marin Co., Calif., Aug. 6, 1938, *Beryl O. Schreiber 2538.*

R. PARVIFLORUS var. VELUTINUS f. **isohypomalacus,** n.f., nodis stipulisque villosis; pedicellis calycibusque non villosis; pedicellorum pedunculorumque glandulis stipitatis 1.0–1.5 mm. longis. TYPE, in Herb. Univ. Wis.: Elk River 6 miles south of Eureka, Calif., Aug. 8, 1938, *Doris K. Gillespie 15398.*

R. PARVIFLORUS var. VELUTINUS f. **parvillosus,** n.f., caulibus, petiolis, pedunculis, pedicellis, calycibusque villosis; pedicellorum pedunculorumque glandulis stipitatis 1–2 mm. longis. TYPE, in Herb. Univ.

Wis.: 1.5 miles southeast of Abbot's Lagoon, Marin Co., Calif., Aug. 6, 1938, *Beryl O. Schreiber 2538*.

R. PARVIFLORUS var. VELUTINUS f. **paramicradenius,** n.f., caulibus stipulisque sparse villosis; pedicellorum pedunculorumque glandulis subsessilibus. TYPE, in Herb. Univ. Wis.: Eureka, Calif., Aug. 6, 1938, *Doris K. Gillespie 15397*.

KEY TO VARIETIES AND FORMS OF *R. PARVIFLORUS*

a. Stem, stipules and petioles without long spreading hairs; leaves of thin texture, not rugose above, their lower surfaces glabrous, glabrate, appressed-pubescent, or moderately velvety; pedicels only very exceptionally with long hairs exceeding the glands; petioles with or without a minute puberulence much shorter than the glands.....var. *genuinus*

b. Pedicels with setae which are usually gland-tipped, the stalks more than 4 times as long as the diameter of the gland

c. Setae of the pedicels gland-tipped

d. Setae 1–2 mm. long

e. Leaves soft-pubescent beneath

f. Calyx not villous.....f. *hypomalacus*

f. Calyx with villous hairs hiding the glands.....f. *villosus*

e. Leaves not soft-pubescent beneath.....f. *heteradenius*

d. Setae mostly about 0.5 mm. long

g. Leaves soft-pubescent beneath

h. Calyx not villous.....f. *bifarius*

h. Calyx with villous hairs hiding the glands.....f. *trichophorus*

g. Leaves not soft-pubescent beneath

i. Calyx not villous.....f. *glabrifolius*

i. Calyx with villous hairs hiding the glands.....f. *Nuttallii*

c. Setae broad-based and not gland-tipped

j. Leaves soft-pubescent beneath.....f. *acephalus*

j. Leaves not soft-pubescent beneath.....f. *adenius*

b. Pedicels glandless or with sessile glands or with glands on stalks less than 4 times as long as the diameter of the gland

k. Leaves soft-pubescent beneath.....f. *micradenius*

k. Leaves not soft-pubescent beneath

l. Calyx not villous.....f. *scopulorum*

l. Calyx with villous hairs hiding the glands.....f. *allocalyx*

a. Stem, stipules and petioles with long spreading hairs; leaves of thickish texture, rugose above, their lower surfaces always densely velvety; pedicels usually with long hairs exceeding the glands; petioles always with a minute puberulence much shorter than the glands.....var. *velutinus*

m. Pedicels with copious villous hairs exceeding the glands

n. Gland-tipped setae of pedicels 1–2 mm. long

o. Calyx not villous.....var. *velutinus* f. *parahypomalacus*

o. Calyx with villous hairs hiding the glands....var. *velutinus* f. *parvillosus*

n. Gland-tipped setae of pedicels about 0.5 mm. long

p. Calyx not villous.....var. *velutinus* f. *parbifarius*

p. Calyx with villous hairs hiding the glands.....
.....var. *velutinus* f. *paratrichophorus*
m. Pedicels without villous hairs exceeding the glands
q. Glands of pedicels on stalks 0.5 mm. or more long
r. Glands of pedicels on stalks 0.5–1.0 mm. long.....
.....var. *velutinus* f. *praebifarius*
r. Glands of pedicels on stalks 1.0–1.5 mm. long.....
.....var. *velutinus* f. *isohypomalacus*
q. Glands of pedicels sessile or nearly so....var. *velutinus* f. *paramicradenius*

4. OCCURRENCE OF FORMS IN MASS COLLECTIONS

Table v is a list of localities where mass collections have been made. Each is numbered, and the numbers refer to localities shown by slanted figures on map 19. Table vi lists the number of individuals of each form represented in each collection.

TABLE V

ONTARIO: *1.* Scattered in woods along the road to Cameron Lake, 6 miles south of Tobemory, Aug. 3, 1938, *20563*. *2.* Small patch in clearing, 8 miles east of Meldrum Bay, Aug. 4, 1939, *20566*. *3.* Large patch along the road and a few in the woods, 7.2 miles east of Meldrum Bay, Aug. 4, 1939, *20565*. *4.* Small patch along the road, 1.7 miles east of Meldrum Bay, Aug. 4, 1939, *20567*. *5.* Roadsides and openings in woods, 1 mile southwest of Meldrum Bay, Aug. 5, 1939, *20568*. *6.* Small patch along roadside, 3.6 miles west of Meldrum Bay, Aug. 5, 1939, *20569*. *7.* Widely scattered patches in spruce-fir and alder woods, 0.7 miles west of Meldrum Bay, Aug. 5, 1939, *20570*. *8.* Scattered in woods and on raised beach, a little along roadside, Meldrum Bay, Aug. 5, 1939, *20571*. *9.* Thicket and openings near Sterling Bay, southern tip of St. Joseph Island, Aug. 3, 1939, *20564*. MICHIGAN: *1.* In birch woods on raised cobblestone (limestone) beach, Gross Cap, 7 miles northwest of St. Ignace, Aug. 1, 1938, *20602*. *2.* Woods at the head of a sand beach, Pointe aux Barques, Aug. 1, 1938, *20601*. *3.* Roadside and pastured woods (aspen, birch, white cedar) 2 miles southwest of Garden City, Aug. 1, 1938, *20600*. *4.* Widespread along roadside and in woods (white cedar, white spruce, birch), Fairport, Aug. 1, 1938, *20603*. *5.* Roadside and along path in woods (fir, white spruce, birch), 5 miles south of Ford River, July 31, 1938, *20580*. *6.* Abundant along the abandoned highway and rare along relocated highway, north of Cedar River, Aug. 1, 1938, *20604*. *7.* Sparse among bracken in aspen woods, 6 miles north of Faithorn, July 30, 1938, *20598*. *8.* Small patch in aspen and Norway pine, 1 mile north of Faithorn, July 30, 1938, *20599*. *9.* Scattered, woods and talus of West Bluff, Keweenaw Peninsula, July 29, 1938, *20494*. *10.* Scattered in fir-white cedar woods near Lake Upson, Keweenaw Peninsula, July 29, 1938, *20557*. *11.* Abundant along roadside, 4 miles southwest of Eagle Harbor, July 29, 1938, *20558*. *12.* Woods and roadsides east of Mohawk, July 29, 1938, *20556*. *13.* Scattered in woods at summit of Wheel Kate, South Range, July 29, 1938, *20561*. *14.* Pathway up Wheel Kate, July 29, 1938, *20577*. *15.* Roadside 2 miles east of Painesdale, July 29, 1938, *20560*. *16.* Woods and roadsides, Toivola, July 29, 1938, *20495*. *17.* Big Limestone Mountain, near

L'Anse, July 29, 1938, *20493*. *18*. Old embankment (highway or R.R.?), Lake Mine, July 29, 1938, *20578*. *19*. Road fill 2 miles southeast of Ontonagon, July 29, 1938, *20574*. *20*. Mouth of Iron River west of Ontonagon, July 29, 1938, *20562*. *21*. Near Ontonagon River, June 28, 1939, *J. T. Curtis*. *22*. Woods and sunny bank, Michigamme, July 30, 1938, *20576*. *23*. Pathway to Carp Lake Mine, Porcupine Mts., July 29, 1938, *20573*. *24*. Foot of talus below Carp Lake Mine, Porcupine Mts., July 29, 1938, *20555*. *25*. Same, one clone, *20559*. *26*. Woods and roadside west of Carp Lake Mine, Porcupine Mts., July 29, 1938, *20579*. *27*. Woods and roadsides, south end of Lake Gogebic, July 28, 1938, *20575*. WISCONSIN: *1*. Scattered along edge of woods, Lake Michigan shore, North Landing, at northern tip of Door Co., July 31, 1938, *20513*. *2*. Roadside, North Landing, July 31, 1938, *20514*. *3*. Almost solid along Lake Michigan shore, Rowleys Bay, July 31, 1938, *20508*. *4*. Roadside and woods (beech and white pine), North Bay, July 31, 1938, *20526*. *5*. Among white pine, hemlock, mountain maple, Baileys Harbor, Aug. 5, 1938, *Chester Cook, C92*. *6*. Woods and clearing near Kangaroo Lake, Baileys Harbor, July 31, 1938, *20515*. *7*. Heavy woods along roadside, Jacksonport, July 20, 1938, *E. M. Gilbert & N. C. Fassett 20509*. *8*. Same data, *20510*. *9*. Abundant in sand back of dunes, among oak, white pine, hemlock, birch and poison ivy, Whitefish Bay, July 31, 1938, *20211*. *10*. Road through woods, Lily Bay, July 31, 1938, *20529*. *11*. Gills Rock, July 31, 1938, *20530*. *12*. Scattered along roadside among beech, birch, white cedar, Sister Bay, July 31, 1938, *20527*. *13*. Field and roadside, Peninsula State Park, near Fish Creek, July 31, 1938, *20511*. *14*. Peninsula State Park, July 22, 1939, *20512*. *15*. Wooded bank near Wildcat Lake, north of Boulder Junction, July 28, 1938, *20543*. *16*. Jute Lake fire tower, northeast of Boulder Junction, July 5, 1939, *J. T. Curtis*. *17*. Barksdale, July 8, 1938, *20541*. *18*. Woods and pathways, Oak Island, off Bayfield Co., July 9, 1938, *N. C. Fassett, J. T. Curtis & Louis Knowlton 20544*. *19*. Roadside and red clay gully, Bark Point, July 10, 1938, *Fassett & Curtis 20545*. *20*. Steep banks below Manitou Falls, Pattison State Park, July 14, 1938, *20542*. MINNESOTA: *1*. Apparently adventive, roadside 4 miles southeast of Gull Lake, Gunflint Trail north of Grand Marais, July 12, 1938, *Fassett & Curtis 20538*. *2*. Near Loon Lake, 10.8 miles south of Gull Lake, July 12, 1938, *Fassett & Curtis 20533*. *3*. Woods and roadside 13.7 miles south of Gull Lake, July 12, 1938, *Fassett & Curtis 20532*. *4*. Roadsides and beaches of Lake Superior near mouth of Kadunce River 8 miles east of Grand Marais, July 12, 1938, *Fassett & Curtis 20537*. *5*. Abundant in old logging road 1.5 miles from shore, Lutsen, July 13, 1938, *Fassett & Curtis 20531*. *6*. Manitou Falls, July 13, 1938, *Fassett & Curtis 20534*. *7*. Illgen City, July 13, 1938, *Fassett & Curtis 20535*. *8*. Gooseberry River, July 13, 1938, *Fassett & Curtis 20536*. SOUTH DAKOTA: *1*. Shady places in canyon south of Pluma, June 26, 1939, *20199*. *2*. Hillside near Pluma, June 26, 1939, *20200*. *3*. North-facing bluff, Fantail, near Lead, June 26, 1939, *20864*. *4*. Frequent in damp pine woods at alt. 2500 ft., Terry, July 2, 1939, *H. C. Cutler 2622*. *5*. Woods 3 miles south of Savoy, June 26, 1939, *20198*. *6*. Open ground, 7 miles north of Savoy, June 26, 1939, *20201*. ALBERTA: *1*. Bordering an aspen grove, near Beaver Mines, about 12 miles west of Pincher Creek, foothills region, southeast of Crow's Nest Pass, June 30, 1940, *E. H. Moss*. *2*. Under aspen and spruce, 10 miles west of Pincher Creek, July 1, 1940, *Moss*. *3*. In lodgepole pine woods near Waterton, Waterton Lakes Park, June 29, 1940, *Moss*. *4*. Edge of woods

and close to shore, same region and date, *Moss*. MONTANA: *1*. North slope, alt. 5500 ft., Bear Canyon east of Bozeman, Aug. 11, 1938, *F. B. Cotner*. WYOMING: *1*. Sunny bank near Steamboat Point, Yellowstone National Park,[28] June 28, 1939, *20209*. *2*. Near Sylvan Pass, Yellowstone National Park, June 28, 1939, *20205*. *3*. Near Tower Falls Junction, Yellowstone National Park, June 28, 1939, *20208*. *4*. Thicket on east side of Jenny Lake, Grand Teton National Park, June 29, 1939, *20206*. *5*. Camp ground in Hoback Canyon, June 29, 1939, *20207*. UTAH: *1*. Wooded canyon on U. S. 40 east of Salt Lake City, June 30, 1939, *20204*. *2*. Roadside in Little Cottonwood Canyon near its mouth, June 30, 1939, *20202*. *3*. Moist woods along stream, Tanners Flat, Little Cottonwood Canyon, June 30, 1939, *20203*. *4*. Moist woods along stream, American Fork Canyon 5 miles from its mouth, July 1, 1939, *20210*. COLORADO: *1*. Scattered in spruce woods, alt. about 8000 ft., Rabbit Ear Pass, 14 miles southeast of Steamboat Springs, July 3, 1939, *20195*. *2*. Roadside and wooded bank, 9 miles south of Steamboat Springs, July 3, 1939, *20196*. *3*. Gorge below Fish Creek Falls, Steamboat Springs, July 3, 1939, *20193*. *4*. Open woods at camp ground, Fish Creek Falls, July 3, 1939, *20197*. *5*. In woods along road to Fish Creek Falls, July 3, 1939, *20194*. *6*. Moist shady hillside, alt. 10,000 ft., Conejos River Canyon, July 24, 1938, *Francis Ramaley 15672*. *7*. Open aspen forest, well-drained soil above the creekbed, Papoose Creek, Yampa River drainage, Rio Blanco Co., Aug. 11, 1938, *F. Ramaley & J. Ewan 16478*. OREGON: *1*. McKenzie Pass, July 15, 1939, *Garland M. Powell*. *2*. Shaded roadside in "black sand" (stabilized dune area), 1.5 miles northwest of Warrenton, Aug. 9, 1938, *W. T. McLaughlin*. *3*. Port Orford, Aug. 12, 1938, *Doris K. Gillespie 15399*. CALIFORNIA: *1*. On beach above Meadow Brook public camp, alt. 5600 ft., Brightman Flats, Tuolumne Co., July 16, 1939, *Ira L. Wiggins 9245*. *2*. Low dense, more or less ground-cover under trees *(Pinus contorta Murrayana, Abies magnifica, Lonicera, Epilobium, Salix)*, ¼ mile north-northeast of Silver Lake, El Dorado National Forest, Amador Co., Aug. 28, 1938, *Beryl O. Schreiber 2546*. *3*. North Fork San Jacinto River, San Jacinto Mts., Aug. 14, 1938, *Carl Epling*. *4*. Fir-spruce association, alt. 1675 m., near head of Nigger Grade, Palomar Mt., San Diego Co., Aug. 4, 1938, *Frank F. Gander 6239*. *5*. Eureka, Aug. 6, 1938, *Doris K. Gillespie 15397*. *6*. Elk River 6 miles south of Eureka, Aug. 8, 1938, *Gillespie 15398*. *7*. Soft chaparral, 1.5 miles southeast of Abbot's Lagoon, alt. 25 ft., Marin Co., Aug. 6, 1938, *Beryl O. Schreiber 2538*. *8*. Dense shade, very moist habitat, woodland, alt. 100 ft., First Valley, Inverness, Marin Co., Aug. 7, 1938, *Schreiber 2539*. *9*. Among scattered dense clumps of *Polystichum munitum* in predominantly grassland areas, alt. 25 ft., 2.5 miles northeast of Point Reyes Lighthouse, Marin Co., Aug. 6, 1938, *Schreiber 2537*. *10*. Thickets on north slope of Strawberry Creek Canyon, 0.7 miles above its mouth, 1100 ft. alt., Berkeley, Aug. 4, 1938, *L. Constance 2397*. *11*. Along banks of Gazos Creek, about 5 miles inland, San Mateo Co., Aug. 12, 1939, *Ira L. Wiggins 9296A*. *12*. Under *Sequoia sempervirens*, ½–1 mile from the ocean, Palo Colorado Canyon, Santa Lucia Mts., about 12 miles south of Carmel, Aug. 7, 1938, *Mildred E. Mathias 1389*.

---

[28] For aid in obtaining a permit to collect specimens in Yellowstone National Park, the writer is indebted to Dr. C. Max Bauer, Park Naturalist, and Mr. C. K. Skinner, Asst. Chief Ranger.

TABLE VI

OCCURRENCE OF FORMS OF TYPICAL *R. PARVIFLORUS*

		Nuttallii	*glabrifolius*	*trichophorus*	*bifarius*	*heterademius*	*villosus*	*hypomalacus*	*ademius*	*acephalus*	*mieradenius*	*scopulorum*	*allocalyx*
ONTARIO	*1*		18		14	1							
	2				2			1					
	3	2	6	2	40								
	4		5		2								
	5		3		4								
	6		8										
	7		1		3								
	8	1	10	1	8								
	9		4		37								
MICHIGAN	*1**					20							
	2				20								
	3		2	1	16	1							
	4		3		19								
	5				17								
	6		2		23						1		
	7			1	13	2							
	8				6	1							
	9		6		23						5		
	10		3		27			4					
	11		11		29								
	12		4	1	15								
	13				23								
	14		1		14								
	15		12		13							2	
	16		2		28						2		
	17		1		46			1			2		
	18		5		15								
	19		2		13								
	*20**				12								
	21		5		4								
	*22**				12								
	23		1	1	14								
	24		10		74			1					
	25†				13								
	26		2	1	25							1	
	27		3		14								
WISCONSIN	*1*		2		4			2					
	2		3		5								
	3		2		19								
	4				18			4			2		
	5		1	1	15						1		
	6		9		10								
	7		2		7	1		1					

* This collection appears to consist of one clone, and does not enter into the data for maps 20–23.

† This collection was made all from one clone, and does not enter into the data for maps 20–23.

TABLE VI (Continued)

		Nuttallii	*glabrifolius*	*trichophorus*	*bifarius*	*heteradenius*	*villosus*	*hypomalacus*	*adenius*	*acephalus*	*micradenius*	*scopulorum*	*allocalyx*
WISCONSIN	*8*				19			1					
	9		1		22	1		1	1				
	10				3			6					
	11		1		19								
	12				8								
	13				14			2					
	14							13					
	*15**				10								
	*16**				13								
	17		3		7								
	18		6	4†	33	1		1			3	1	
	19		3	3	15	2					1		
	20		7		1								
MINNESOTA	*1**				21								
	2		2		12								
	3		14		4	1		1					
	4		5	1	30	1		1					
	5		2		30	1						1	
	6		2		11						1		
	7				16			1			1		
	8		9		8			1					
SOUTH DAKOTA	*1*		5									20	
	2		3									3	
	3	2	5									5	
	4		20									8	
	5		6								1	21	
	6											9	1
ALBERTA	*1*		5									15	
	2	1	10		13						3	2	
	3		17									19	
	4		10		2						1	11	
MONTANA	*1**											47	
WYOMING	*1*		8										
	2		18	2									
	3		4										
	4	5	32									6	
	5											10	
UTAH	*1*											5	
	2		22										
	3		2									30	
	4	2	14	4	28	3							

* This collection appears to consist of one clone, and does not enter into the data for maps 20–23.

† Two of these have villous pedicels, which have been found elsewhere only in var. *velutinus*.

TABLE VI (Continued)

		Nuttallii	*glabrifolius*	*trichophorus*	*bifarius*	*heteradenius*	*villosus*	*hypomalacus*	*adenius*	*acephalus*	*micradenius*	*scopulorum*	*allocalyx*
COLORADO	*1*											3	1
	2	1	20									3	
	3		10		1						8	21	
	4		14									12	
	5		3								2	19	
	6										1	1	
	7		3										
OREGON	*1*				7								
	2		4		20								
	3				10			5		10			
CALIFORNIA	*1*		21										
	2										14		
	3				20			4					
	*4**				4		4	9					
	5†										2		
	6‡				10			2			4		

* This collection also contains one individual of var. *velutinus*.
† This collection also contains 25 individuals of var. *velutinus*.
‡ This collection also contains 12 individuals of var. *velutinus*.

5. IS *R. parviflorus* A PREGLACIAL RELIC ABOUT THE UPPER GREAT LAKES?

The initiation of the present study was an attempt to combine two ideas. The first, published by Professor Fernald,[29] was expressed as follows: "The high bluffs of Keweenaw evidently were not denuded by Wisconsin ice and, consequently, they served as centers on which many species survived . . . , some later to spread slightly to lower levels and, in case of readily dispersed species, like *Rubus parviflorus* . . . , to extend over much of the Upper Lakes region . . . " The second, elaborated by Dr. Sewall Wright and others, has been expressed by Dobzhansky[30] in the words: "A finite population left to its own devices must, therefore, suffer a progressive decay of its hereditary variability and sooner or later must reach a complete genetic uniformity." Again,[31] "The

[29] *L. c.*, p. 216.
[30] Genetics and the origin of species, p. 130. 1937.
[31] *Ibid.*, 132.

TABLE VII

OCCURRENCE OF FORMS OF *R. PARVIFLORUS* VAR. *VELUTINUS*

		paratrichophorus	*parbifarius*	*parvillosus*	*parahypomalacus*	*praebifarius*	*isohypomalacus*	*paramierademius*
CALIFORNIA	*4**		1					
	5†	5	6			12		2
	6‡		6			5	3	
	7	4	5	3	14			
	8		25		3¶			
	9	5		3				
	10		42					
	11§	32						
	12	36	16					

* This collection also contains 17 individuals of typical *R. parviflorus*.

† This collection also contains 2 individuals of typical *R. parviflorus*.

‡ This collection also contains 16 individuals of typical *R. parviflorus*.

¶ Some pedicels bear only short-stalked glands; others in the same inflorescence bear long-stalked glands.

§ Inflorescences 1–few-flowered with long pedicels, resembling but more extreme than those illustrated for var. *parviflorus* (Fernald, *l.c., plate 365, fig. 1*).

smaller the population size, the more rapid is the scattering of the variability and the eventual attainment of genetic uniformity.''

If, then, *Rubus parviflorus* was once confined for a long time on one or few nunataks about Lake Superior it should show less variation in that region than in some other parts of its range. Actually this proved to be only partially the case. In so far as variation is expressed in the number of forms in each region, as listed in tables VI and VII, it is just as variable in Wisconsin as in California, and in Michigan as in Colorado. But while the number of forms is about the same in each region, their proportions differ from region to region. A study of the proportions of individuals displaying each character, in each region, shows that the loss of variability by the suppression of minority characters has gone a little farther in the Great Lakes region than elsewhere. This is expressed mathematically in table IX, page 344.

While the range and amount of variation are about the same in all regions, the number of forms varies greatly from colony to colony within each region. This may be seen in table VI under Ontario, where collections 2–8 are all from the vicinity of Meldrum Bay, and the number of forms in each collection varies from one to four. The number of forms in any colony is not entirely a factor of the age of the colony, in the sense discussed by Dobzhansky, but depends, as in *R. odoratus* (see page 307), on how many seeds started the colony and whether the colony has increased in size by vegetative spread or by seed reproduction.

While *R. odoratus* grows most commonly on recently cut soil, *R. parviflorus* does not have this soil preference. In regions where the climate is favorable (this factor will be discussed later) it forms a solid growth along the roadside (beautifully pictured by Fernald, *l. c., pl. 363)* and also occurs as scattered stems, connected by rootstocks, in thick woods. In places where a road cuts through woods, the writer has tried unsuccessfully to determine whether the plant had established itself along the roadway and spread into the woods, or was originally scattered in the woods and had expanded along the roadway (pl. 9, fig. 1). In either case, and whatever the period of occupancy of the Upper Great Lakes area, the entire *R. parviflorus* population of that area appears to be functioning as one breeding unit rather than as many isolated units. In map 22 the collections about the Great Lakes have been grouped into regions and a pie-diagram made for each region, just as was done for *R. odoratus,* except that now 6 characters are used instead of 4 as in the eastern species; the diagrams for the six regions in map 22 show close similarity, as do those in the southern part of the glaciated territory in map 3, rather than the dissimilarity shown in the unglaciated parts of map 3.

In map 20 the stations listed in table V, shown by solid dots, have been grouped into seven regions; each region has been demarked by a line and given a name. From the data in tables VI and VII a pie-diagram has been made for each region. These pie-diagrams show the plants of the Coast Ranges of California to be very distantly related to those of all the other

regions: this is consistent with the taxonomic treatment of the plants of the Coast Ranges as a separate variety. Also evident is the rather close resemblance among the four central regions of Alberta, Wyoming, Black Hills and Colorado. Less to be expected is the resemblance of the Great Lakes region to the Sierra region. The significance of this will be pointed out below.

From the figures in the pie-diagrams the averages of differences of percentages between regions have been computed in the way described on page 311. Table VIII shows the averages of

TABLE VIII

AVERAGES OF DIFFERENCES OF PERCENTAGES BETWEEN REGIONS

	Great Lakes	Black Hills	Wyoming	Alberta	Colorado	Sierra	Coast Ranges
Great Lakes	–	33	19	25	30	8	41
Black Hills	33	–	15	8	3	25	68
Wyoming	19	15	–	8	12	14	53
Alberta	25	8	8	–	5	17	61
Colorado	30	3	12	5	–	23	66
Sierra	8	25	14	17	23	–	43
Coast Ranges	41	68	53	61	66	43	–

percentages of differences between all regions, and many of these are also shown on maps 20 and 21 by large figures superposed on heavy lines connecting regions. Lower numbers indicate closer relationship, and these figures bring out more positively the observations of the preceding paragraph.

On map 21 are shown only the average percentage differences of less than 10. Again the close relationships are emphasized, one of the Rockies and the Black Hills, and the other of the Great Lakes and the Sierra region.

It is this latter fact which appears to the present writer as of great importance in the consideration of the claim of *Rubus parviflorus* to the title of preglacial relic in the Middle West. If the great gap in its range (see map 24) has been due to a former continuous range having been bisected by ice-sheets between Lake Superior and the Black Hills, these two regions could be expected to show a close relationship. On the contrary, the relationship between these two regions appears on map 20 as remarkably remote. The Great Lakes region shows much closer connection with the region along the Pacific coast (Oregon) and inland California; this connection, since it was not across Wyoming, Colorado, or the Black Hills, was presumably across a more northern region. Before discussing this possibility it is necessary to determine what ecological factors influence the range of this plant.

Map 25 shows the range of *Astragalus caryocarpus,* a characteristic plant of prairies and plains. On the same map are shown the maximum extent of Pleistocene glaciation, and the Fall Line, but there is no obvious relationship between either of these and the range of the plant. Comparison with map 26, however, shows the correlation of this range with provinces of low humidity. It may now be observed that the range of *Astragalus caryocarpus* almost exactly FITS INTO THE GAP in the range of *Rubus parviflorus* (map 24). If both are controlled by one factor, the reaction of one plant is positive, that of the other negative. The range of the *Astragalus* is correlated with aridity; is that of the *Rubus* correlated with humidity?

Definitely, it is. Figures for a suitable portrayal of regions on a basis of humidity are not available, and if they were they would not include the microclimates so important in plant distribution. But some facts are clear without figures, and the following personal observations have convinced the writer of the dependence of *Rubus parviflorus* on a relatively high humidity and low summer temperature.

On the north shore of Lake Superior, in Minnesota, the Thimbleberry is an aggressive plant, occurring not only in woods and openings along the shore and in canyons entering

the lake, but as a common weed in many places. Particularly vivid was the experience of Dr. J. T. Curtis and the writer at Lutsen, where we were able to follow the elusive overgrown old lumber roads, only by the still persistent line of Thimbleberry (pl. 9, fig. 2). It has similar weedy habits near the shore of Bayfield County, Wisconsin, on the Apostle Islands, and in the Porcupine Mountains and on Keweenaw Point in the Upper Peninsula of Michigan. On Keweenaw Point it grows in the towns, forming a hedge between houses (pl. 10, fig. 3).

Inland the aggressiveness decreases. While it is apparently adventive along the Gunflint Trail going north from Grand Marais, Minnesota, it seems to be almost absent north and west of Duluth. This seems to be due partly to the slightly warmer area north of Duluth (map 27) and even more to the dry west winds of this region (map 28).

In northern Wisconsin the southern limit of Thimbleberry is near the 66° July isotherm (map 27). In the canyon of Manitou Falls about 15 miles south of Superior, Wisconsin, it barely exists; it was possible to find only eight scattered and dwarfed flowering individuals. Likewise in Vilas County, Wisconsin, it is uncommon and usually not aggressive, although Dr. Curtis reports a thrifty colony at Jute Lake. In the more southern stations in Wisconsin it is confined to the heavier soils, while nearer Lake Superior the soil preference is scarcely marked.

In Door County, Wisconsin, the Thimbleberry is rare on the Green Bay side of the peninsula, but on the Lake Michigan side it makes an almost solid growth, as is shown on map 27. Its aggressiveness well south of the 66° July isotherm is due to local conditions. Mr. Eric R. Miller, Meteorologist in Charge of the United States Weather Bureau at Madison, to whom I am also indebted for assistance in procuring the data from which maps 27 and 28 were drawn, tells me that the west side of Door County peninsula is warmed by the southwest winds which follow Green Bay, whereas the east side of the peninsula is cooled by proximity to Lake Michigan; this difference in temperature is not shown by readings from one station at the

tip of the peninsula and another near its base, but is noticeable when one drives across the peninsula. In the local cool zone along the Lake Michigan shore the saturation deficit would be lower even if the relative humidity were the same on the two sides, which it probably is not, due to frequent fog on the lake and local breezes from over the water.

Dr. R. F. Griggs has recently called attention to the concentration of rare plants, many of them considered by some botanists to be preglacial relics, on islands and peninsulas,[32] and in telling of the weedy tendencies of some of these plants he specifically mentions *Rubus parviflorus* in Keweenaw.[33] It is weedy in Keweenaw Point because on the peninsula it is favored by low temperature (map 27) and by the prevailing west winds (map 28) blowing across the lake and carrying moisture. It is also weedy along the Minnesota shore of Lake Superior where the atmosphere is cool and moist, and this weedy tendency is carried inland in the Arrowhead of Minnesota to a limited degree. On the Apostle Islands at the tip of Bayfield County, Wisconsin, and to a slightly less extent on the adjacent mainland, the Thimbleberry is rather aggressive in following roadsides and woodland trails. This is true also in the Porcupine Mountains and about Ontonagon, Michigan. In Door County, Wisconsin, as already mentioned, conditions on the two sides of the peninsula make the plant rare on one side and very abundant on the other.

Elsewhere in its range in the Lake states the Thimbleberry tends to grow on roadsides and along margins of woods, but it is scarcely aggressive or abundant; its normal weedy propensities are curbed by the absence of completely favorable atmospheric conditions.

I do not understand the distribution north of Lake Huron. On the peninsula of Bruce County, Ontario, the Thimbleberry is very rare, and I have seen it only in woods near Cameron Lake. It is abundant about Meldrum Bay at the west end of Manitoulin Island and occurs in open ground on St. Joseph Island southeast of Sault Ste. Marie. I have traversed much

[32] Bull. Torr. Bot. Club **67**: 589. 1940. [33] *Ibid.*, p. 583.

of the shore line of Bruce Peninsula, of Manitoulin Island, of St. Joseph Island, and of Drummond Island, and while of course a statement that it is not present except as shown on map 27 would be too sweeping, it is certainly absent in many localities apparently as suitable as those in which it is abundant farther west, and seemingly just as favorable as the few spots where it is found. Perhaps it is just in the process of spreading into this region and grows where seeds have happened to land.

There appear to be no collections from the north side of the Upper Peninsula of Michigan between Sault Ste. Marie and Munising. I have not collected along this shore except at Brimley, 15 miles west of Sault Ste. Marie, where the red clay banks would seem favorable for Thimbleberry, but none was found.

In the summer of 1939 I went as far west as Utah and Colorado for the specific purpose of collecting quantities of this plant. The eastern botanist traveling for the first time from southern Wisconsin across Minnesota and South Dakota to the Black Hills will soon abandon the idea that glaciation accounts for the absence in these regions of various species common in the eastern forests. Even if he has been familiar with rainfall maps, etc., he will not fail to be impressed by driving hours on end through progressively treeless plains, and then for mile after mile in a monotony of cactus and sagebrush. But on reaching the Black Hills, he will find again a region of forests, streams and swamps, of brook trout and beaver, and of such familiar eastern mesophytes as ostrich fern, bloodroot, columbine, dwarf Solomon-seal, etc.[34] In the cool and moist canyons of the northern Black Hills the Thimbleberry grows; Dr. Hayward's paper brings out its ecological relationships in his illustrations. His Fig. 7 shows Spearfish Canyon, which supports a heavy stand of white spruce with quantities of Thimbleberry; this is characteristic of a small region surrounded by country pictured in his Figs. 8–11, where the absence of Thimbleberry can by no means be attributed to glaciation.

[34] Cf. Hayward, H. E. Bot. Gaz. **85**: 353–412. 1928.

To the easterner visiting the western states for the first time the conditions about Salt Lake City are most striking. Rising from the arid plains and bordering the Wasatch Range are the terraces of Lake Bonneville, impressive evidence of a once great body of water. On the parched sides of the Wasatch Range are sagebrush, shadscale, rabbitbrush and greasewood (pl. 11, fig. 5), but in the canyons are heavy forests and rushing streams of icy water from the snowfields above—one might almost be persuaded that he is back in Glen Ellis in the White Mountains. It is in these cool moist canyons that the Thimbleberry grows (pls. 11-12, figs. 6, 7). The occurrence of Thimbleberry in mountainous areas and its absence in intervening lowlands is shown in map 36.

These observations convince the writer that the gap in the range of *Rubus parviflorus* is due to aridity and not to glaciation.[35] It is easy to concur with Professor Fernald's statement,[36] "it seems quite illogical to argue that such species . . . have been arriving in post-Wisconsin times from different remote centers outside the area of general Pleistocene glaciation . . ."; the cross-continental migration must have been ancient, even if postglacial. In the same paragraph he expresses doubt that they could have made this migration "without leaving in their long hypothetical cross-country journeys a somewhat continuous train of intermediate stations." Had he said "more or less continuous" it would have been easier to agree, for the intermediate stations are "more" for some species and "less" for others. They are *less* continuous for *Polystichum Lonchitis* (207),[37] *Ceanothus sanguineus* (210), *Vaccinium membranaceum* (211), *Adenocaulon bicolor* (213) and many others, and for some other species they are *more*. Some of these other species will be discussed in the next paragraph.

[35] This statement is deliberately worded to refer to one species and one alone. Professor Fernald points out (*l. c.*, pp. 212–213, 217–218) that both mesophytes and xerophytes show this gap in their ranges. The present investigation concerns but one species and the conclusion is that *that* species is not a preglacial relic.

[36] *L. c.*, p. 208.

[37] Figures refer to the page numbers where these are mapped in Professor Fernald's paper.

Hultén decries[38] the practice of basing conclusions exclusively on extreme types of range, as follows: "When tackling the problems offered by the geographical areas of plants, many authors have chosen to discuss peculiar or singular types having a distribution out of the common, in the hope that they will suddenly give a clue to the solution of the problem. . . . It is surely more rational to start the investigation with the simplest types, those that show the least possible peculiarities. When they have been interpreted, the complicated and often strongly interrupted areas of the singular or peculiar types are likely to be better understood."

Populus balsamifera (map 29) has a broad range across the northern part of the continent, chiefly in glaciated regions; this range seems obviously to have been attained in postglacial time. The same is true of *Picea glauca* (map 30), but its southward extension down the Rockies and into South Dakota has been lost, leaving outliers in the Black Hills and in Montana. The range of *Arabis divaricarpa* (map 31) is becoming definitely pinched in the region northwest of Minnesota. This trend has resulted, in *A. Drummondi* (map 32), in a breach between the eastern and the western parts of the range, with a few scattered intermediate stations—this is one of the *more* species of the preceding paragraph. An even wider gap appears in *Botrychium Lunaria* (map 33), but comparison with map 29 shows how a distribution like that of the *Botrychium* might have been derived from one like that of the *Populus*. If the derivation was of this nature, and the distribution of the *Populus* is clearly postglacial, then the range of the *Botrychium* is postglacial also. It is a short step from a range like that of *Botrychium Lunaria* to one like *Rubus parviflorus* (map 34), whose occurrence east of the Rockies has been reduced to the Black Hills and the vicinity of Lakes Superior, Michigan and Huron.

Perhaps it is dangerous to imply that the various gaps in the ranges shown in maps 29–34 are due to the varying toler-

[38] Outline of the history of Arctic and boreal biota during the Quarternary period, pp. 9–10. 1937.

ance of the low humidity in the region between the Great Lakes and the moist ravines of the western mountains, since a decreasing tolerance of low humidity shown by these species is not easily demonstrated experimentally. However, it is not necessary to explain to a botanist familiar with the northern states and southern Canada that balsam poplar and white spruce are found in a greater variety of habitats than is Thimbleberry. While the former is by no means rigid in its requirements, it does need a comparatively cool, moist climate. In the Middle West, wherever Thimbleberry grows, white spruce ordinarily grows also, but where white spruce grows Thimbleberry does not necessarily accompany it. The limiting factors of the Thimbleberry are the same as those of the white spruce, but to a greater degree.

When, then, did the Thimbleberry spread from the western regions to the Great Lakes? At some time when the climate was sufficiently cool and moist for white spruce to spread from coast to coast, and south to the Black Hills. Perhaps this was while glacial influence was still felt[39]; perhaps it was during some later humid period. It may be significant that in spite of the large number of eastern woodland species isolated in the Black Hills there has not been described a single endemic variety of an eastern species from that region. These species must, then, have entered the Black Hills fairly recently. And conditions which would permit plants like bloodroot to spread westward to the Black Hills might also permit a migration of Thimbleberry eastward along a more northern route.

Rubus parviflorus did not populate the Black Hills from the same stock as that which reached the shores of the Great Lakes.

[39] "The glaciations were connected with such great changes in climate that it is unthinkable that the Great Basin should not be influenced by them. Low temperature checking evaporation probably made itself felt when the ice-sheet began to grow in Canada. Later also precipitation must have become greater. These cooler and moister conditions, begun at an early stage of the glaciations, gradually increased, and the highest point of moisture was reached during the pluvial periods which seem to have been a consequence of the great climatic change which checked the further expansion of the ice-sheets and caused their disappearance." Antevs, Ernst. On the Pleistocene history of the Great Basin. Carnegie Inst. Wash., Publ. No. 352: 74. 1925.

The Thimbleberry population of the Black Hills was derived from the Rocky Mountains; map 21 shows the close relationships within the regions designated as Alberta, Wyoming, Colorado and the Black Hills. The stock which spread into the Middle West must have existed to the northward, and have spread southeastward at about the same time it migrated southwestward along the Pacific coast to northern California and down the Sierras, for the populations of this far western region are closely similar to those of the Middle West (map 21).

The amount of variation of *R. parviflorus* in the Great Lakes area as compared to that in the western parts of its range has already been mentioned (page 333). Qualitatively the variation is the same in both regions, for the same forms are found in each. Quantitatively, however, variation in the Great Lakes area is less than elsewhere. This is shown by the pie-diagrams on map 20. The diagram for Great Lakes shows, in sector B, that 93 per cent of the individuals have glands on the pedicels 0.5–1.0 mm. long; this indicates that the population is within 7 per cent of uniformity on that character. Figures of 38 per cent in the Black Hills, 42 per cent in Colorado, etc., show much less approach to uniformity. Figures approaching 100 per cent or 0 per cent both indicate a corresponding approach to uniformity, while figures approaching 50 per cent indicate more variation. It is possible to average the amount of deviation from uniformity in all characters shown by the population of a region. For the Black Hills region, for example, this is obtained by averaging the following: 1 from sector A (for 99 per cent deviates from 100 per cent, or uniformity, by 1), 38 from sector B (38 per cent deviates from 0 per cent, also uniformity, by 38), 38 from sector B (62 per cent deviates from 100 per cent by 38), 3 from sector D, and 0 from sectors E and F. This average (1 plus 38 plus 38 plus 3 plus 0 plus 0, divided by 6) is 13, the variability index for the Black Hills. If the population of a region were uniform in all characters, the figures in each sector would all be 100 or 0, and the variability index would be 0. In a population showing maximum variation, half

the individuals with glabrous leaves and half with velvety leaves, and a similar equal division in each of the other sets of characters, the variability index would then be 50.

TABLE IX

VARIATION INDEX OF EACH REGION

Great Lakes	3
Black Hills	13
Alberta	19
Wyoming	13
Colorado	16
Sierra	11
Coast Ranges	12

Table IX shows the same facts that a comparison of the pie-diagrams on map 20 shows visually: the population of the Great Lakes area has less variation than that of any other area.

This small amount of variation, or close approach to uniformity, indicates, according to the ideas expressed by Dobzhansky,[40] that this population has been at one time much reduced in number of individuals. Here, perhaps, is the only support lent by the present study to the theory that *R. parviflorus* survived glaciation on a nunatak in the vicinity of Lake Superior, for in case of such survival the persisting colony would have been very small and its descendants would lack variation. However, glaciation was not the only event which might have reduced the size of the Great Lakes population. "A late postglacial prehistoric dry period with more widespread drought conditions and more prolonged droughts than at present is definitely indicated by certain bog pollen studies, by soil profile, by the succession in bog profiles, by the absence, or rare occurrence, of many tree, shrub, and herbaceous species from the region of the [Prairie] Peninsula, and by the present distribution of prairie colonies, and prairie species."[41] Such a warm dry period is recorded as having prevailed in Wisconsin, probably not very long ago, and certainly since the third

[40] See quotations on page 332.

[41] Transeau, Ecology **16**: 435. 1935.

Wisconsin glaciation.[42] During such a period the Thimbleberries of the Great Lakes area may well have been temporarily reduced to a very small population.

Ever since they were isolated about the Great Lakes, whether by changes in climate or by glaciation, the Thimbleberries of that region have functioned as but one breeding population. Had they survived on two or more nunataks[43] and spread out later so that colonies from the two or more centers merged, the very long isolation as very small populations would have reduced greatly the variation in each colony, with very little chance of each colony retaining the same forms in the same proportions. That this did not happen is shown by the striking uniformity of variations in all the regions about the Great Lakes (maps 22 and 23).

A final word concerning the occurrence of the species in California: var. *velutinus* of the Coast Ranges stands out as distinct from all the other populations (table VII and map 20). It would appear that the Coast Ranges have been continuously humid while other parts of western North America have been experiencing fluctuations in humidity, so that the Thimbleberries have had a continuous existence there for a long time. Aridity at some period separated the race in the Coast Ranges (var. *velutinus*) from the main body of the species. The subsequent readvance in California brought the two races again into contact at the two ends of the Great Valley (map 35, and California collections 4, 5 and 6 in tables IV and V).

Summary

Both *Rubus odoratus* and *R. parviflorus* show variation in the glands and pubescence of calyces, pedicels, petioles, blades and stems. With the exception of *R. parviflorus* var. *velutinus* the various combinations of types of pubescence and glands are treated as forms.

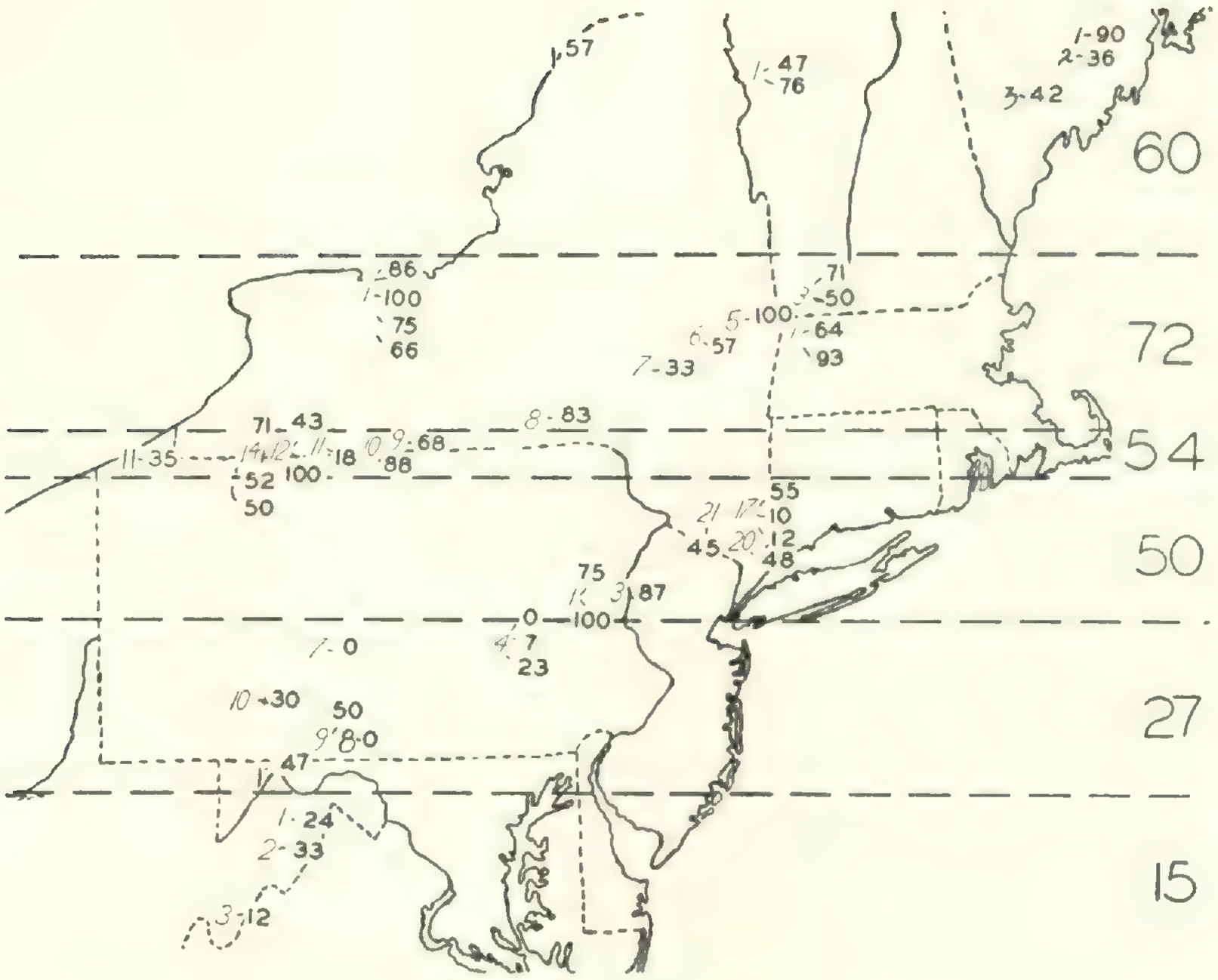
[42] Truman, Trans. Wis. Acad. **30**: 40. 1937.

[43] Professor Fernald states or implies the possibility of nunataks in the following regions: Slate Islands (*l.c.*, p. 197), Bruce Peninsula (p. 201), Cloche Peninsula (p. 203), Keweenaw Peninsula (p. 204), and elsewhere (p. 217).

In *R. odoratus* the percentage of individuals with essentially glabrous leaves increases progressively from West Virginia to Maine. The percentages of individuals with a certain type of short-stalked gland on the pedicels does not show such a definite progression. Colonies in regions not glaciated show less resemblance, statistically, than do those in glaciated regions. Colonies in southern Indiana, probably isolated since before the earlier Pleistocene glaciations, show relationship most distant from eastern colonies.

In *R. parviflorus* most of the recently proposed varieties appear invalid, having no definite ranges, occurring intermixed in nearly all colonies, and being founded on combinations of characters which also appear in nearly all possible recombinations. The colonies of the Coast Ranges of California show sufficient isolation of some characters so that var. *velutinus* is maintained for them.

Colonies in the Rocky Mountains show close resemblance to each other in the proportions of occurrence of each character. The colonies about the Great Lakes are more closely related to those of the Oregon coast and the Sierras. It is concluded that the occurrence of the plant about the Upper Great Lakes is due, not to the survival of a preglacial flora on nunataks, but to migration across Canada during a postglacial cool humid period and subsequent bisection of the range by the aridity of the Great Plains.

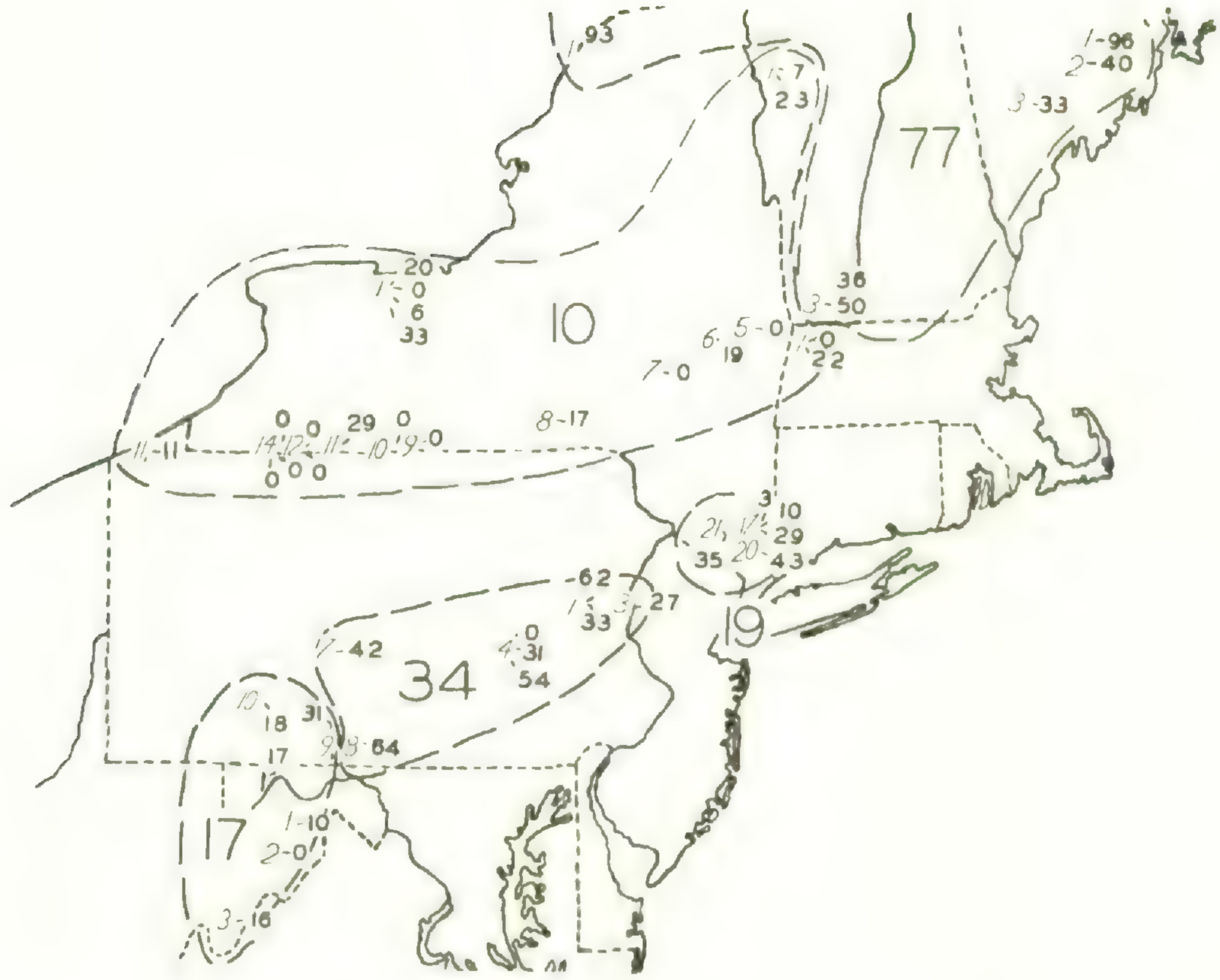


MAP 1

Slanted figures: locations of mass collections. A new series of numbers starts in each state or province.

Erect figures to the right of, or above or below, the slanted figures: per cent of individuals in each collection with leaves glandless above and glabrous or glabrate beneath.

Large figures on right margin: per cent of individuals in each zone (between broken horizontal lines) with leaves glandless above and glabrous or glabrate beneath.



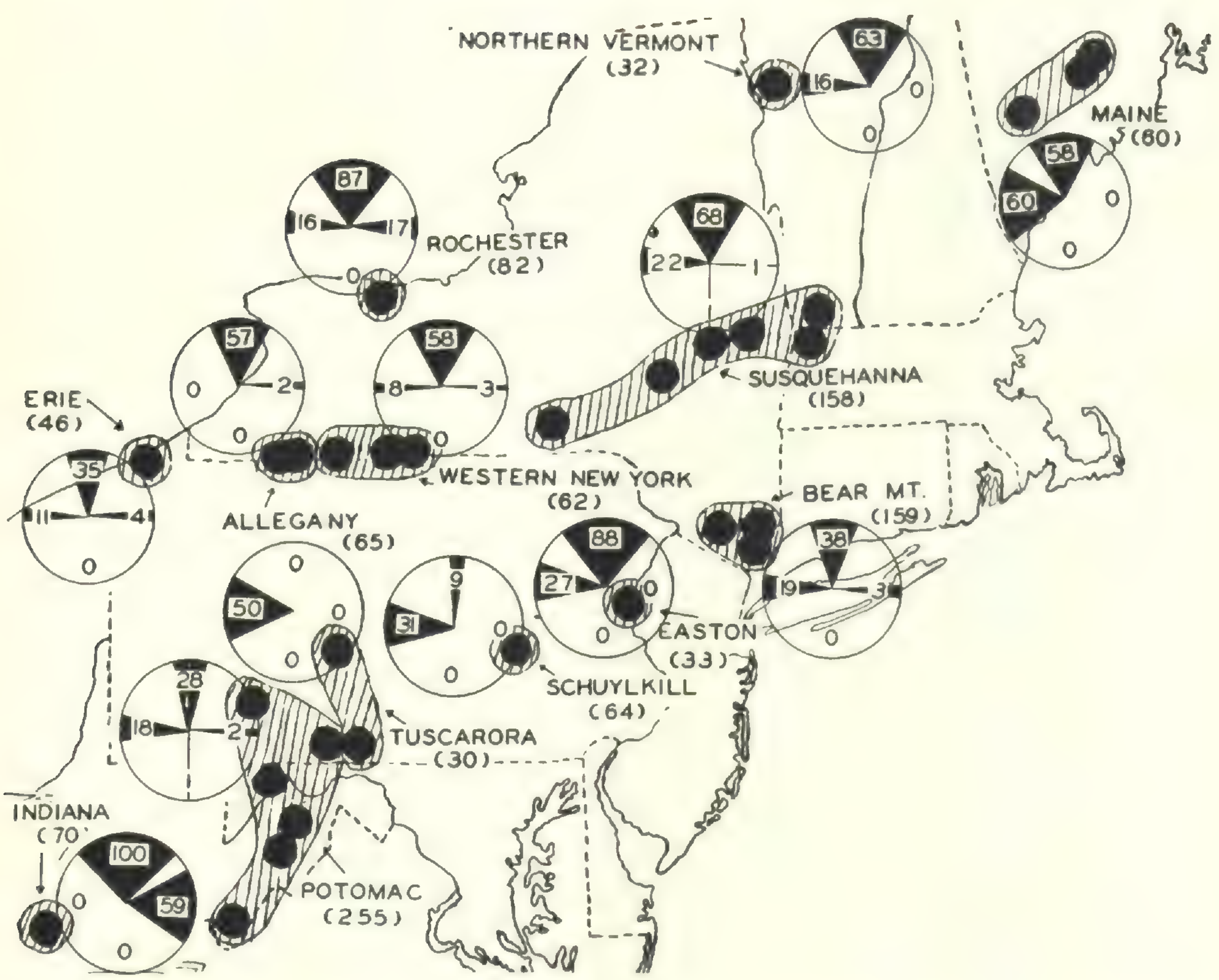
MAP 2

Slanted figures: locations of mass collections.

Erect figures to the right of, or above or below, the slanted figures: per cent of individuals in each collection with glands on the pedicels 0.5–1.0 mm. long.

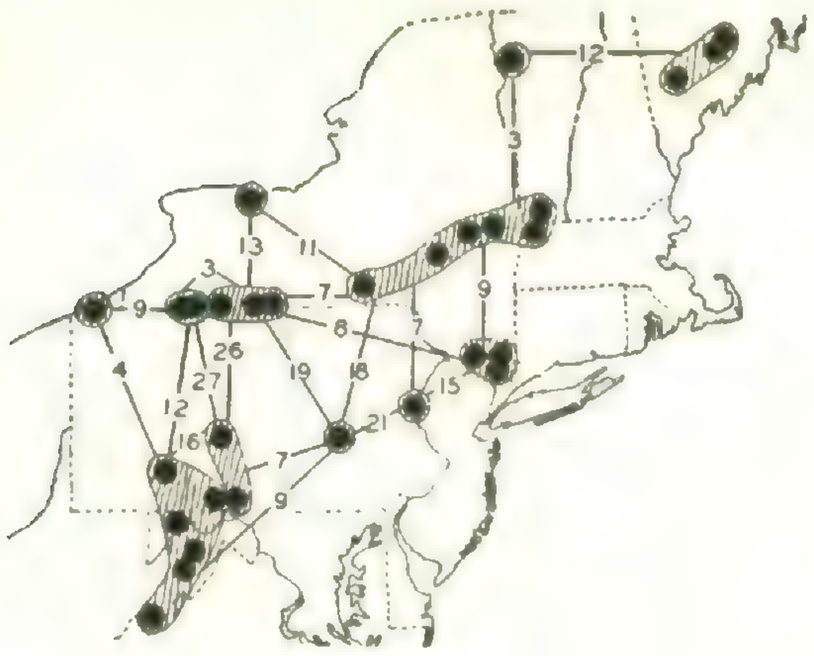
Large figures: per cent of individuals in each region (enclosed in broken lines) with glands on the pedicels 0.5–1.0 mm. long.

Erratum: Vt. 4—change 50 to 60.

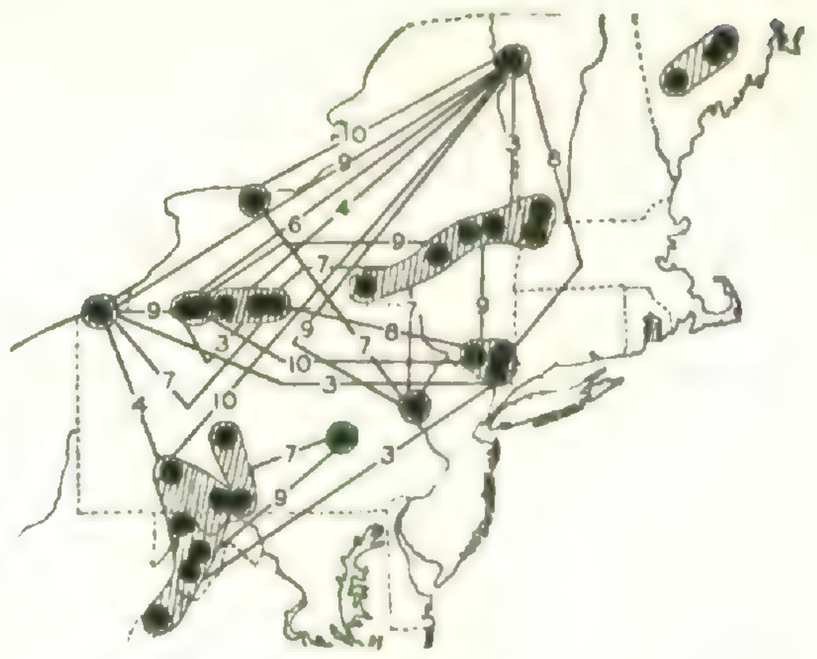


MAP 3

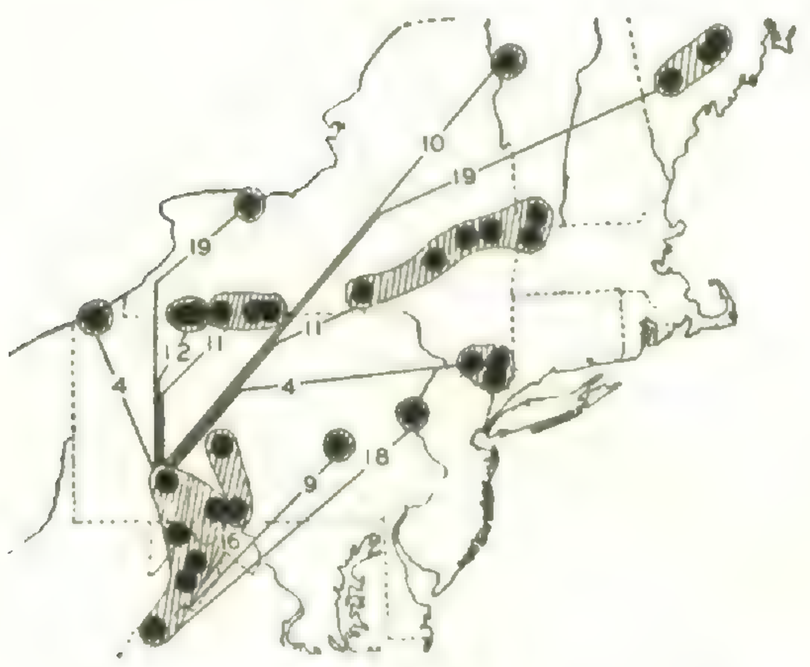
Stations where mass collections have been made (dots) grouped into regions (vertically lined). The figure in parentheses below the name of each region is the number of individuals collected in that region. In the pie-diagram for each region, each sector represents a character, and the figure in the sector shows the percentage of total individuals having this character, as follows: upper sector, per cent of individuals with leaves glandless above and glabrous or glabrate beneath; left sector, per cent of individuals with glands on the pedicels 0.5–1.0 mm. long; lower sector, per cent of individuals with glands of pedicels sessile or subsessile; right sector, per cent of individuals with glands 1.0–2.5 mm. long on the lower sides of veins of leaves. To conserve space, Indiana is inserted in the lower left corner.



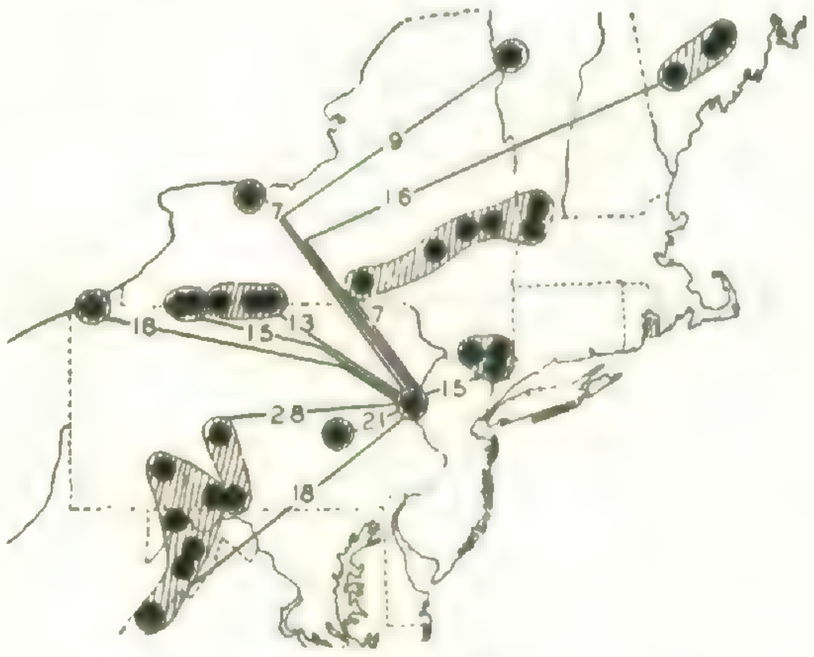
MAP 4



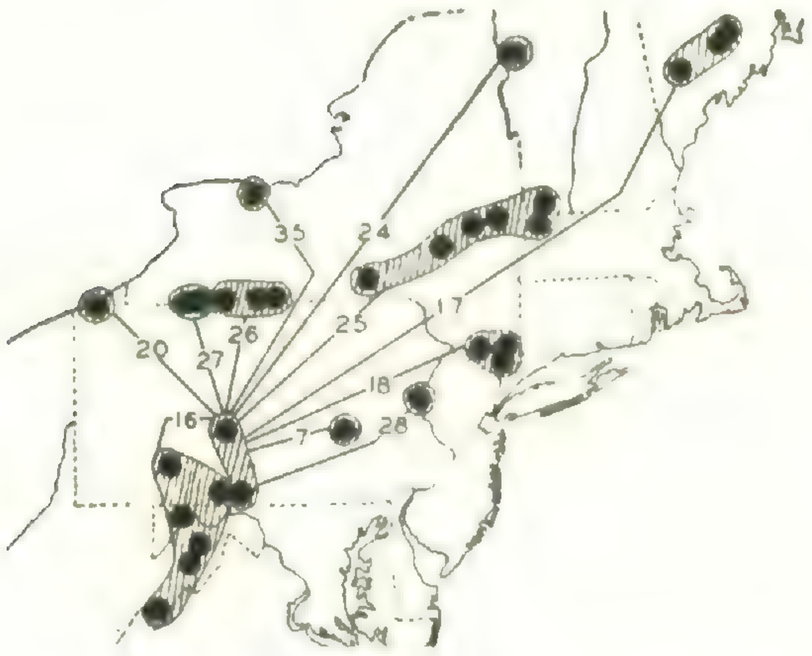
MAP 5



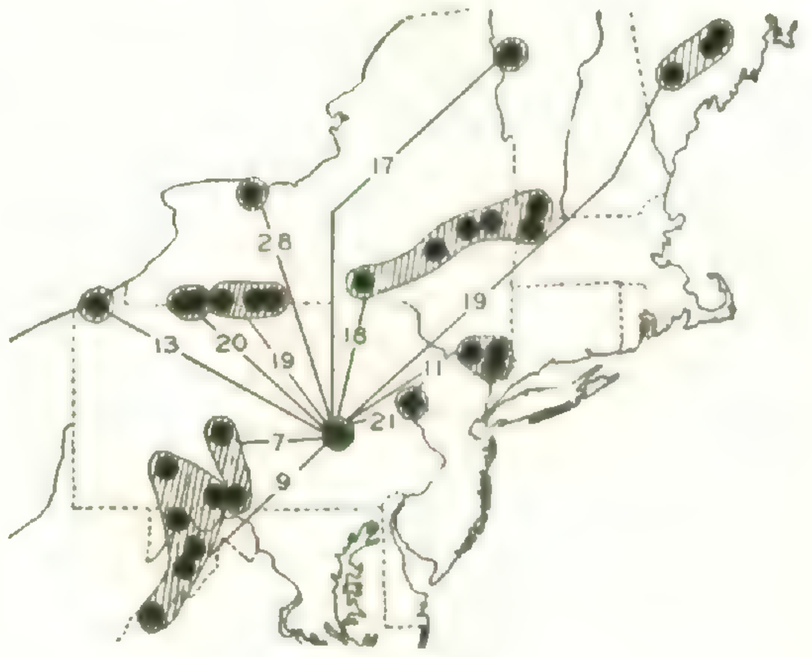
MAP 6



MAP 7



MAP 8



MAP 9

MAP 4. Averages of differences between adjacent regions, derived from map 3; relations between neighboring regions in the more southern post-Wisconsin areas (southern New York State) are close, those between pre-Wisconsin areas (central Pennsylvania and southward) are mostly fairly close, and those between pre-Wisconsin and post-Wisconsin areas are mostly distant.

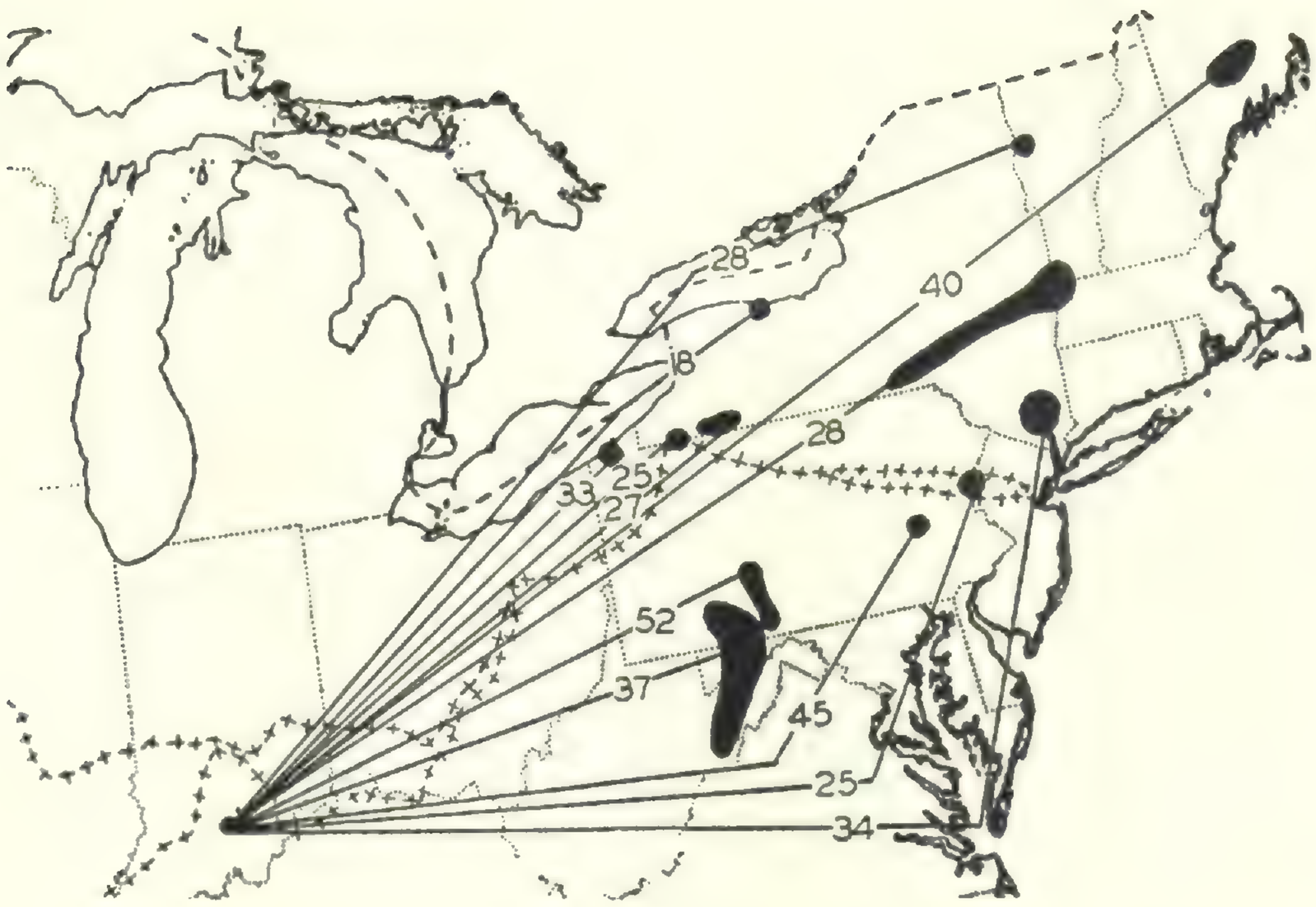
MAP 5. Differences of 10 or less, derived from map 3.

MAP 6. Differences between the Potomac region and other regions, derived from map 3.

MAP 7. Differences between the Eastern region and other regions, derived from map 3.

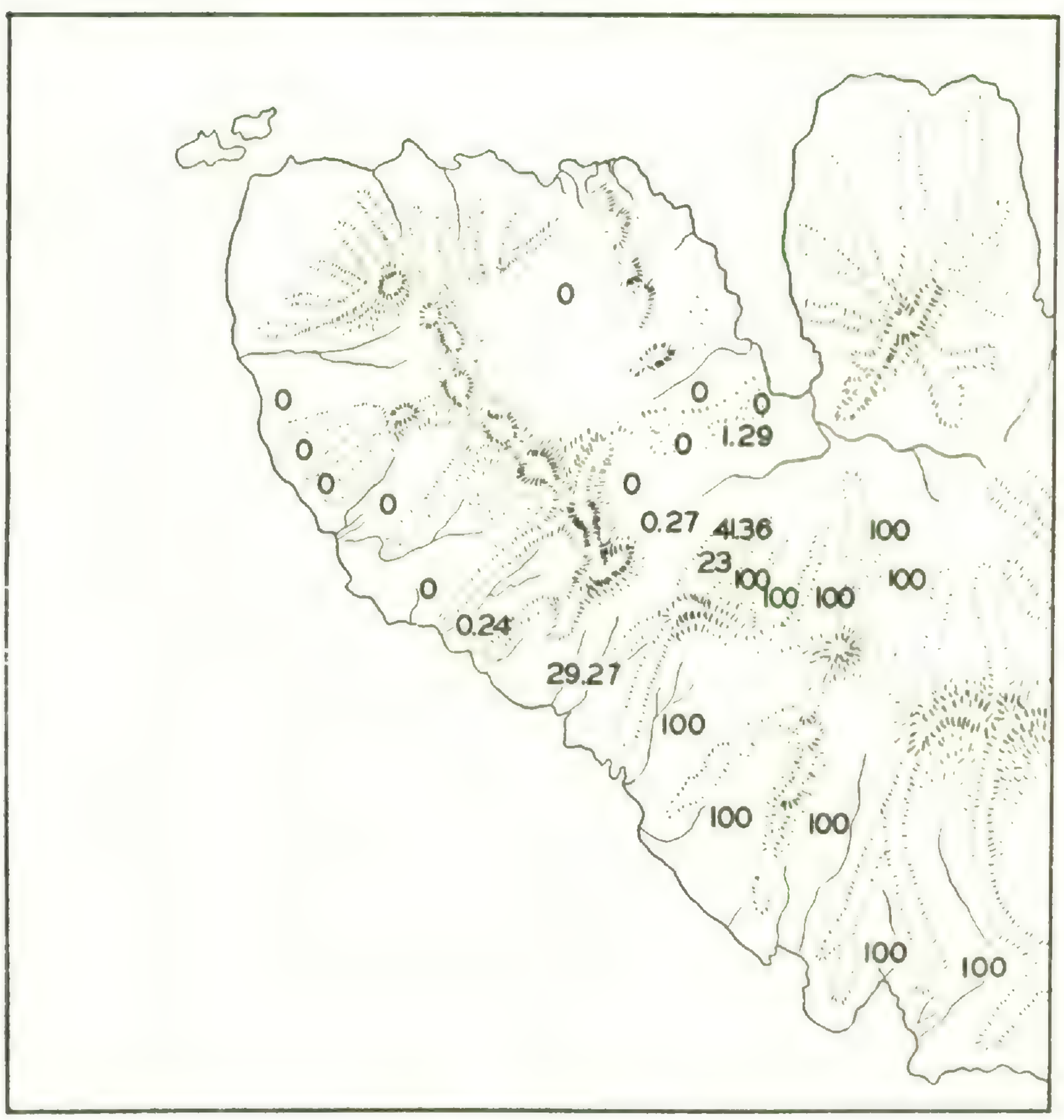
MAP 8. Differences between the Tuscarora region and other regions, derived from map 3.

MAP 9. Differences between the Schuylkill region and other regions, derived from map 3.



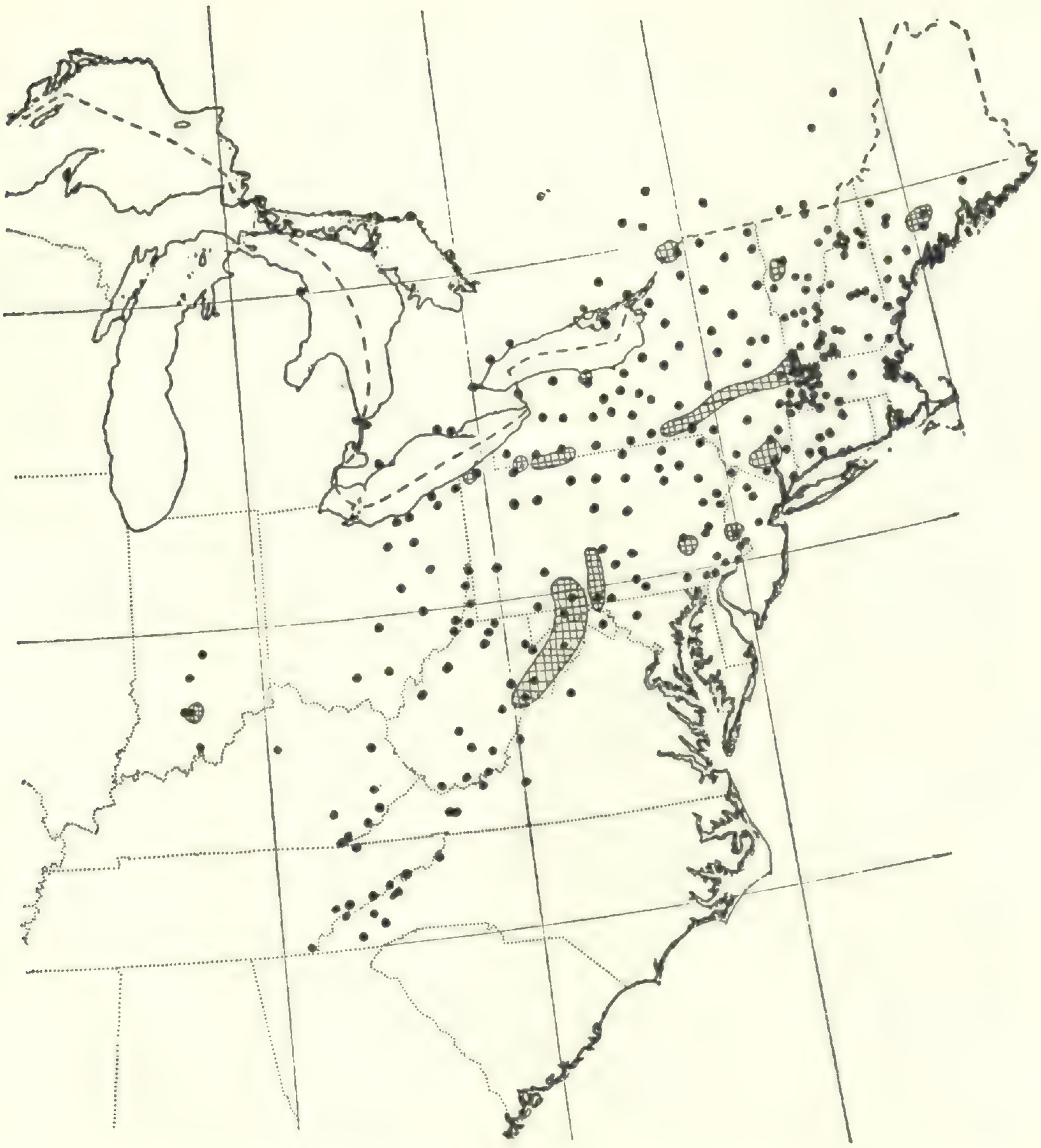
MAP 10

Differences between the Indiana region and other regions. The line of crosses represents the southern limits of glaciation; where this line splits, the southern part delimits Wisconsin glaciation and the northern part the earlier glaciations. The base map is Hall's Outline Map, 801M.



MAP 11

Western part of the island of Moorea. The figures indicate the proportion of dextral individuals in each isolated valley, for the snail *Partula suturalis*. Data from Crampton, *l.c.*, tables 10 & 11.



MAP 12

Cross-hatched areas: regions where mass collections of *R. odoratus* have been made. Dots: range (excepting Nova Scotia), based on collections in the Gray Herbarium, New York Botanical Garden, New England Botanical Club, New York State Museum, the Universities of West Virginia, Toronto, Pennsylvania, Kentucky, Cincinnati, Tennessee, and Wisconsin, the records of Dr. E. Lucy Braun and Dr. R. M. Harper, Schaffner's 'Ohio Vascular Plants,' and Deam's 'Flora of Indiana.' The base map is Hall's Outline Map, 801M.

MAP 13

R. parviflorus var. *genuinus.* Dots: range according to Fernald. X's: other collections.

MAP 14

R. parviflorus var. *hypomalacus.* Dots: range according to Fernald. X's: other collections.

MAP 15

R. parviflorus var. *heteradenius.* Dots: range according to Fernald. X's: other collections.

MAP 16

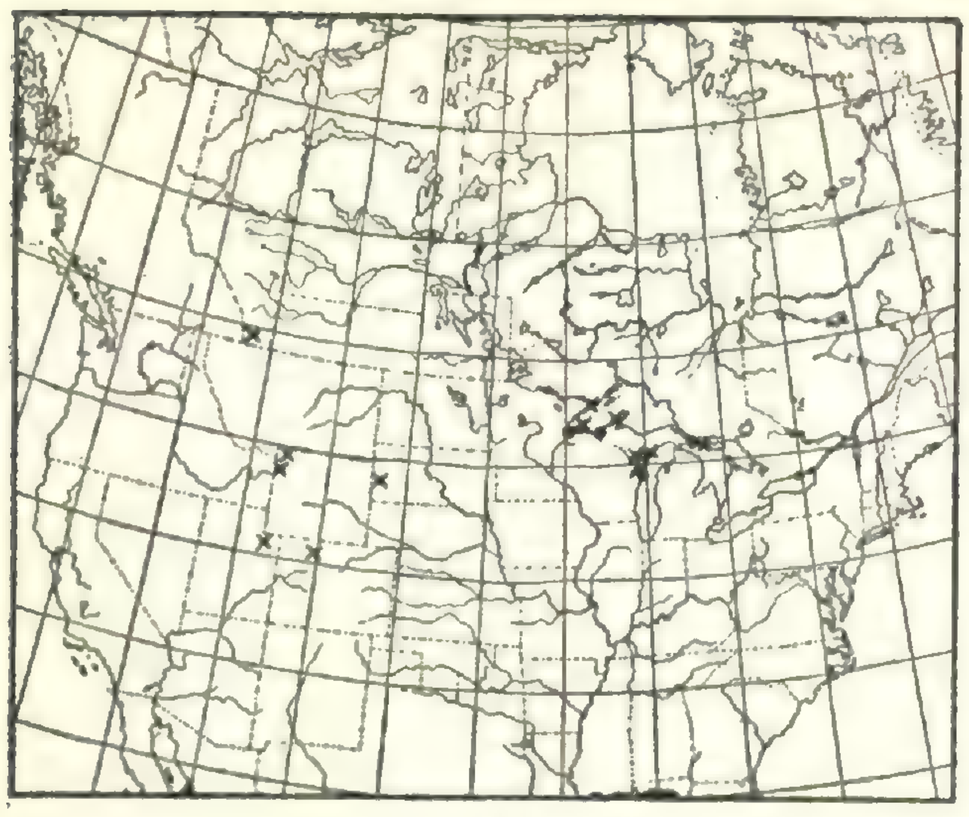
R. parviflorus var. *bifarius.* Dots: range according to Fernald. X's: other collections.

MAP 17

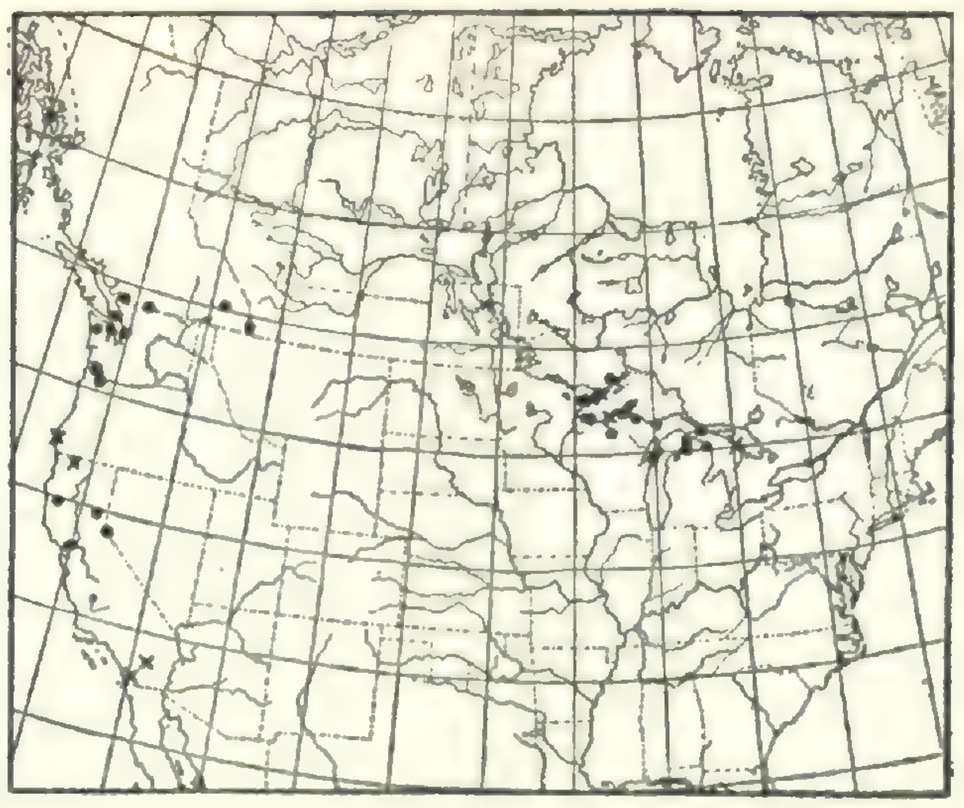
R. parviflorus var. *grandiflorus.* Dots: range according to Fernald. X's: other collections.

MAP 18

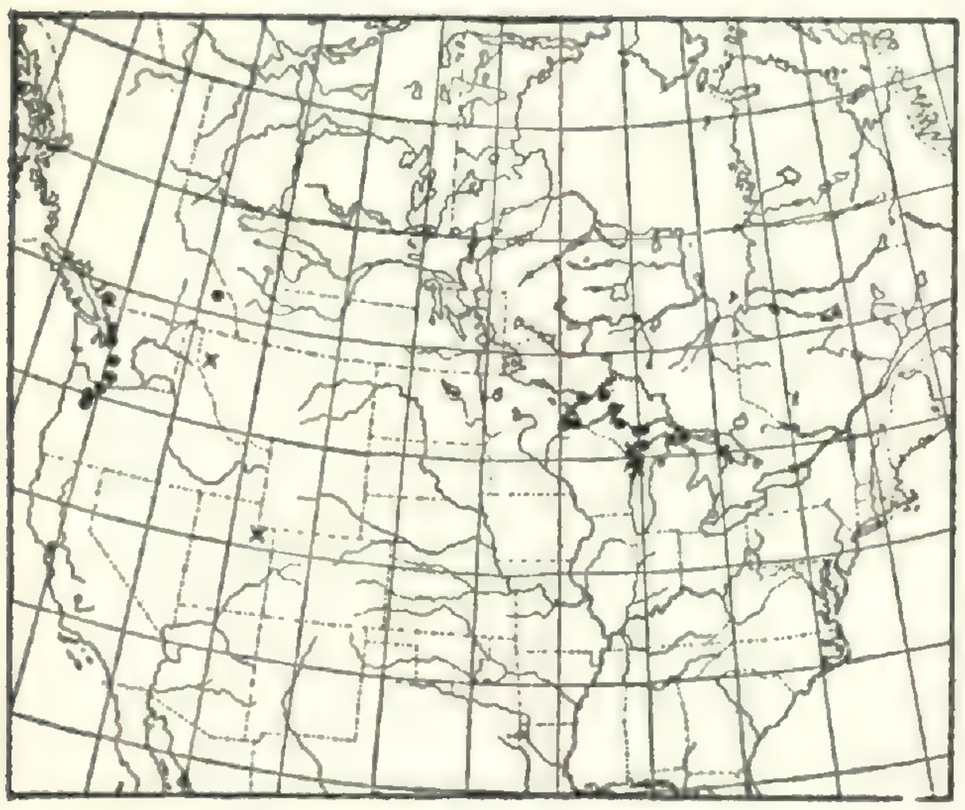
Dots: *R. parviflorus* var. *scopulorum,* and triangles, var. *parvifolius,* ranges according to Fernald. X's: other collections of these two varieties. Crosses: other collections of plants like them but with leaves velvety beneath.



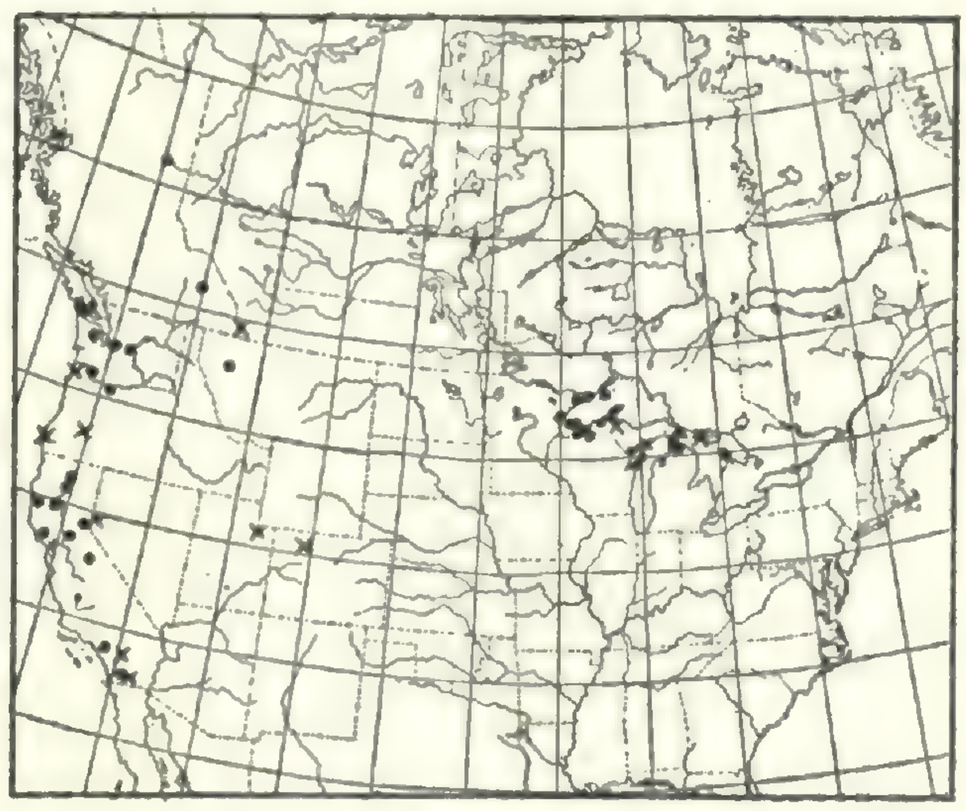
13



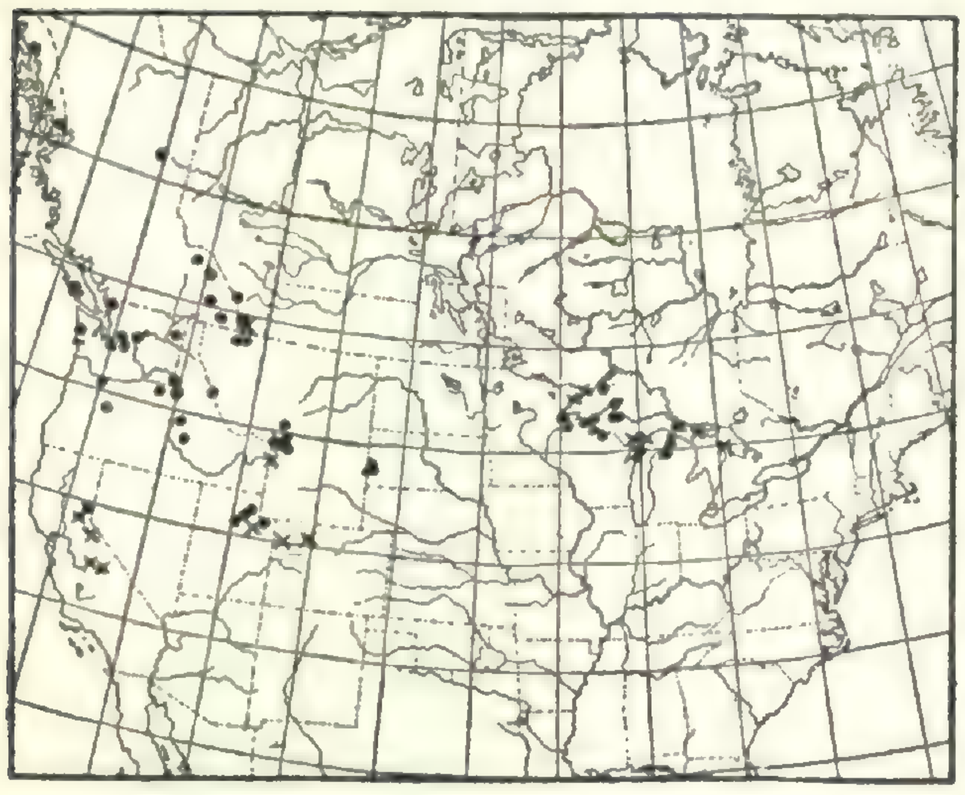
14



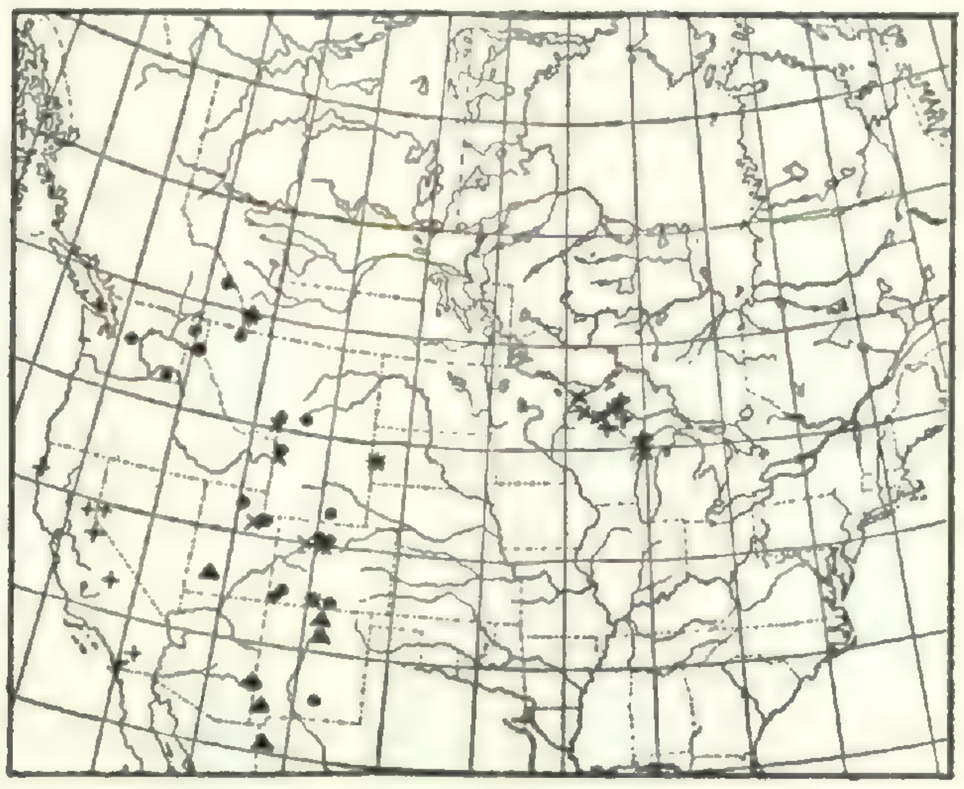
15



16



17



18

MAP 19

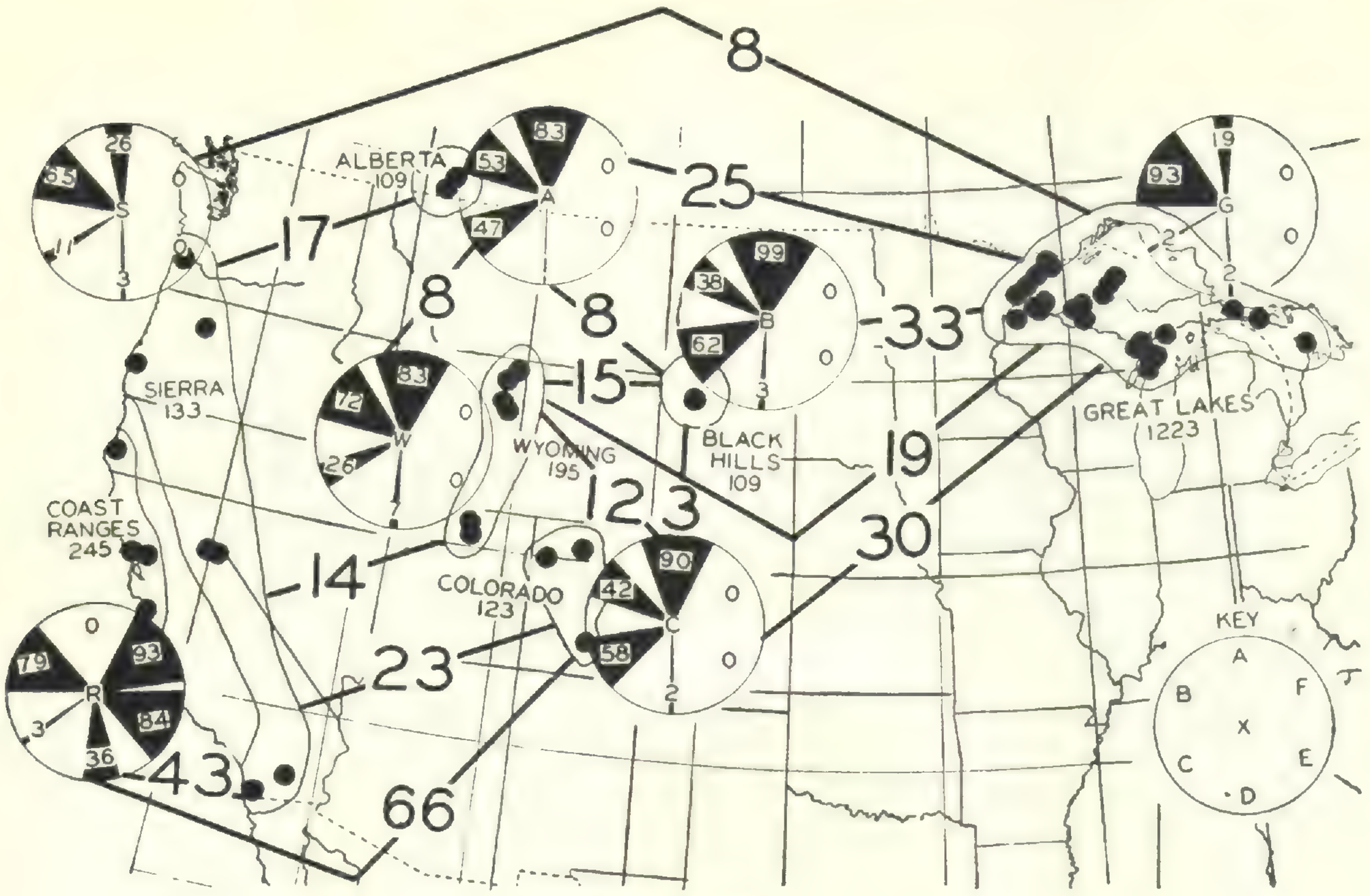
Slanted figures show locations of mass collections of *R. parviflorus*. A new series starts in each state or province, and figures missing indicate localities close to the locality bearing a lower number. The base map is Hall's Outline Map, 801M.

MAP 20

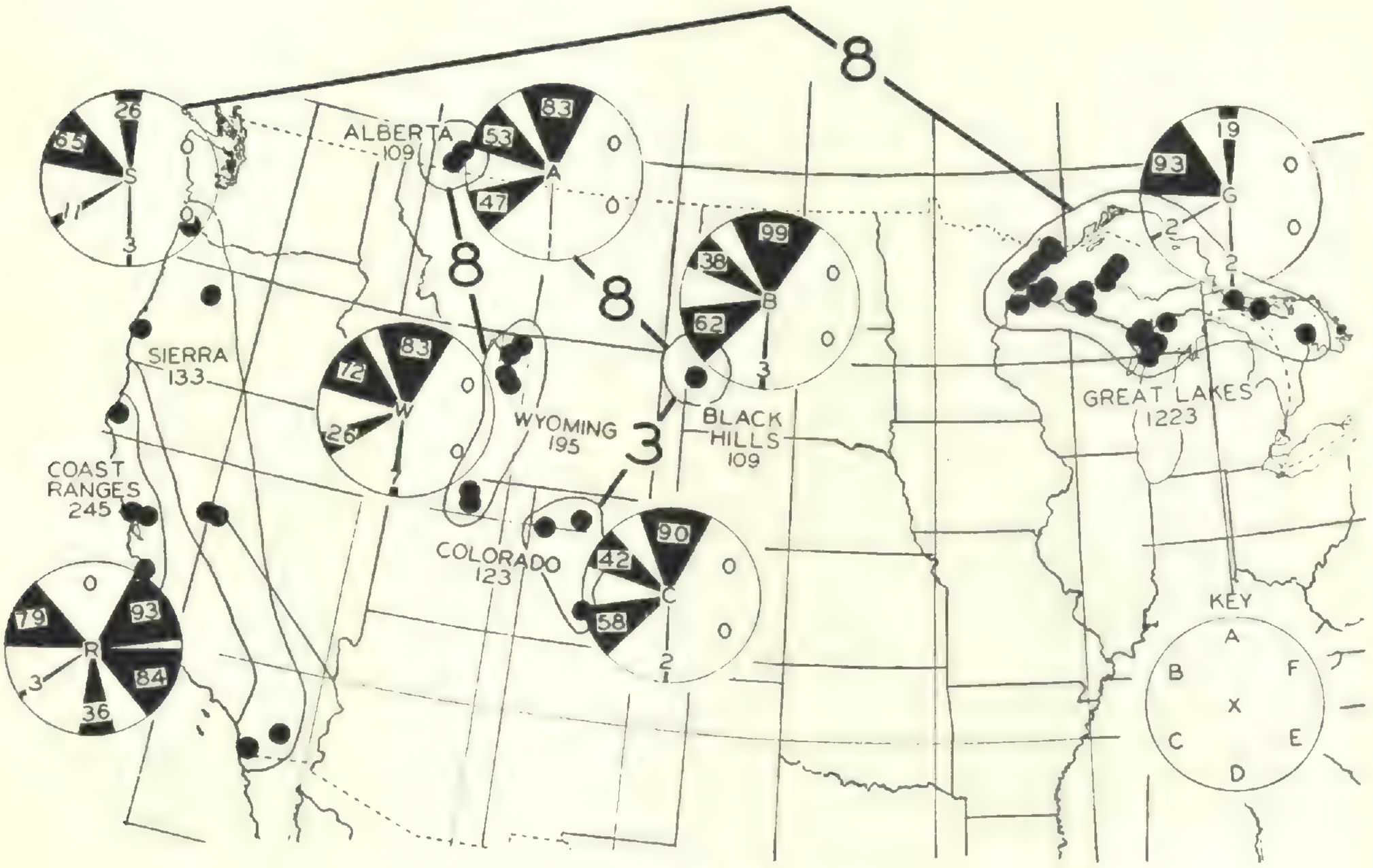
Stations where mass collections of *R. parviflorus* have been made (dots) grouped into regions (enclosed by lines). The figure below the name of each region indicates the number of individuals collected from that region. A pie-diagram for each region indicates in each sector the percentage of occurrence of a character as follows (refer to key): sector A, per cent of individuals with leaves glabrous or glabrate beneath; sector B, per cent with glands 0.5–1.0 mm. long on the pedicels; sector C, per cent with glands sessile or subsessile on the pedicels; sector D, per cent with villous calyx; sector E, per cent with villous pedicels; sector F, per cent with stem, stipules and petioles villous. In the center of each diagram (position X) is an initial referring to the name of the region. The average differences between regions (from table VIII) are shown by large figures on the heavy lines connecting regions.

MAP 21

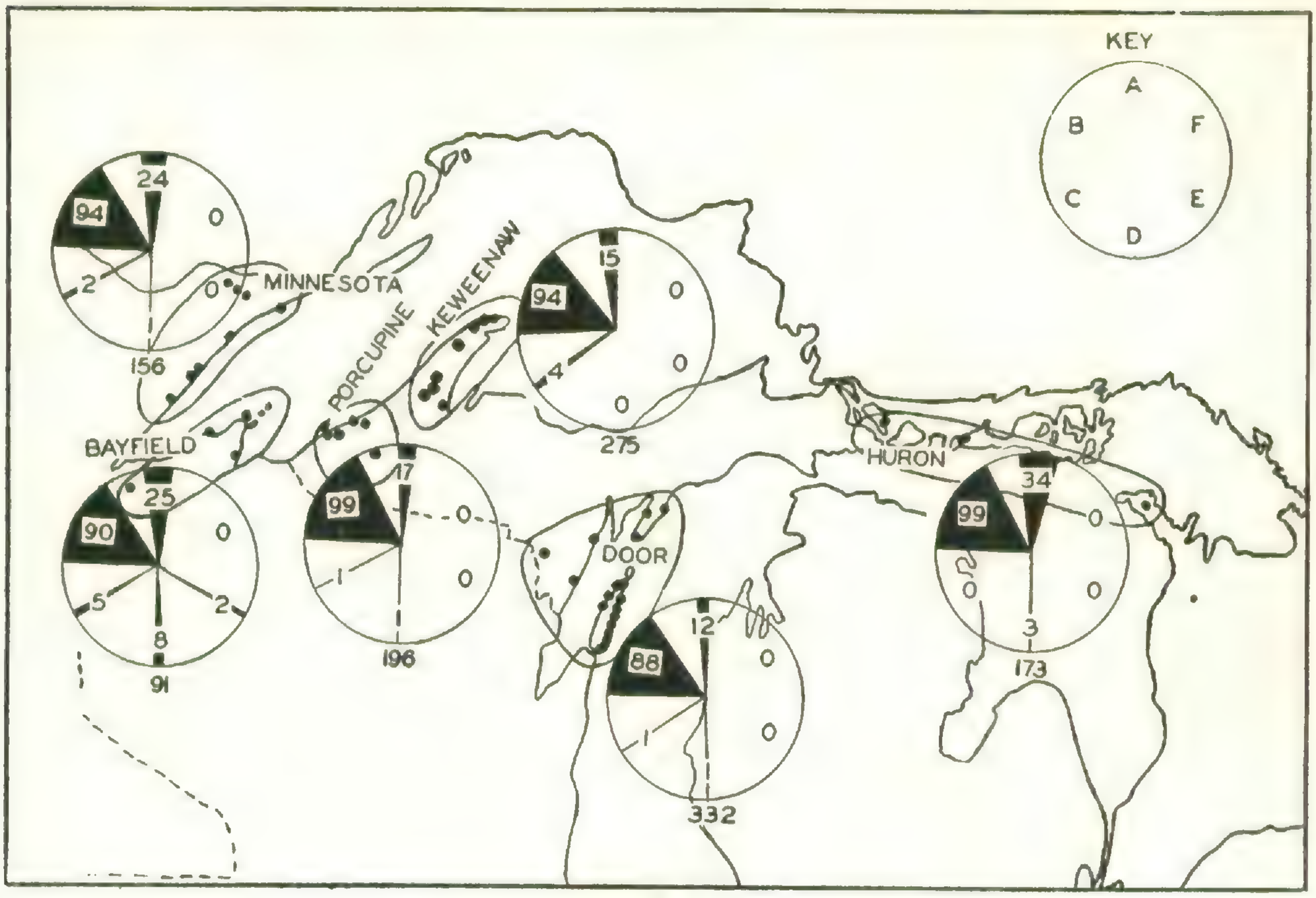
Differences less than 10. The base map for maps 20 and 21 is Hall's Outline Map, 801M.


8
ALBERTA
109
25
17
8
8
SIERRA
133
15
33
BLACK
HILLS
109
19
GREAT LAKES
1223
WYOMING
195
123
COAST
RANGES
245
14
COLORADO
123
30
KEY
23
66
43
A
B
C
D
E
F
X
G
S
W
R
C

MAP 20

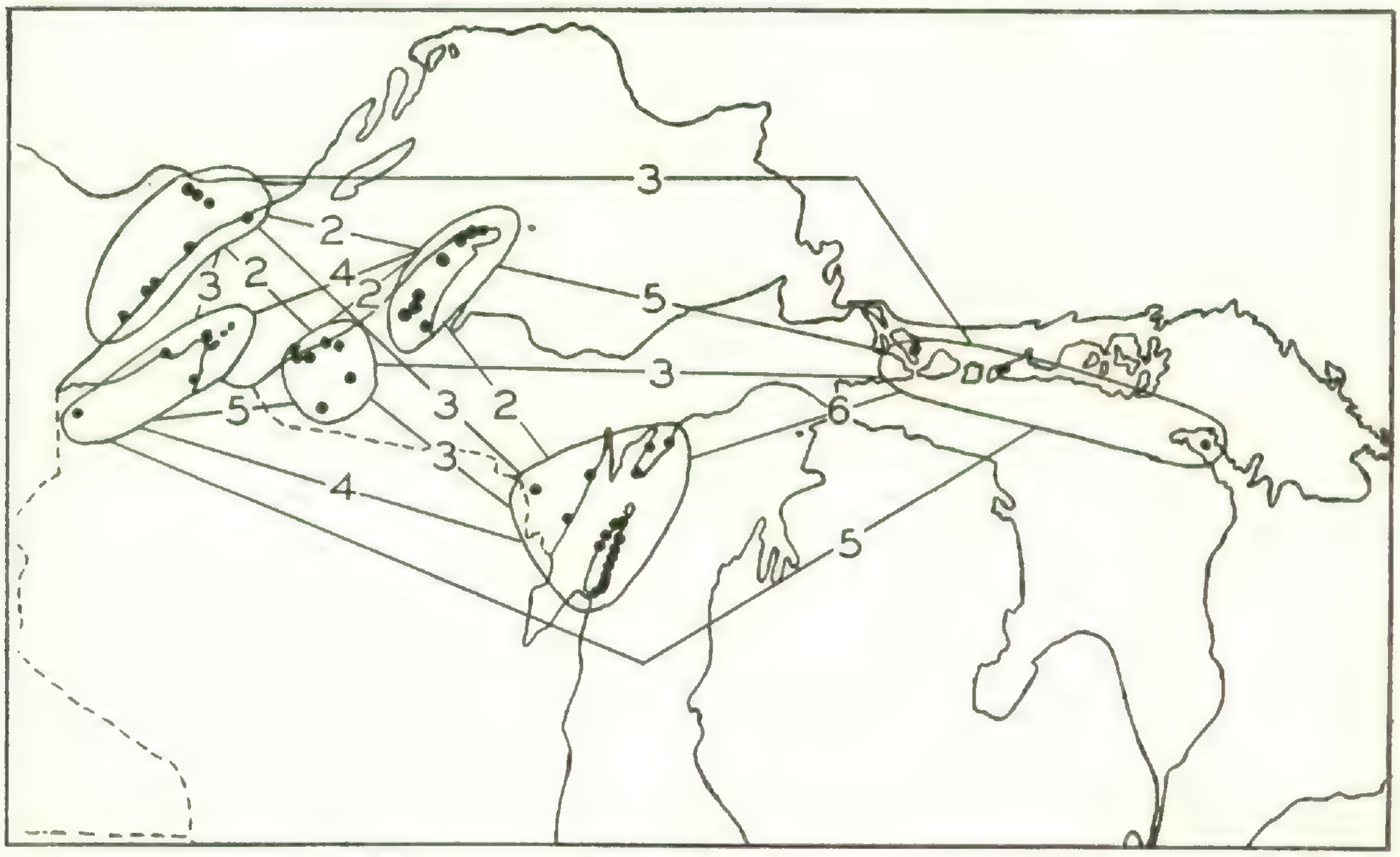

8
ALBERTA
109
8
8
SIERRA
133
3
BLACK
HILLS
109
GREAT LAKES
1223
WYOMING
195
COAST
RANGES
245
COLORADO
123
KEY
A
B
C
D
E
F
X
G
S
W
R
C

MAP 21



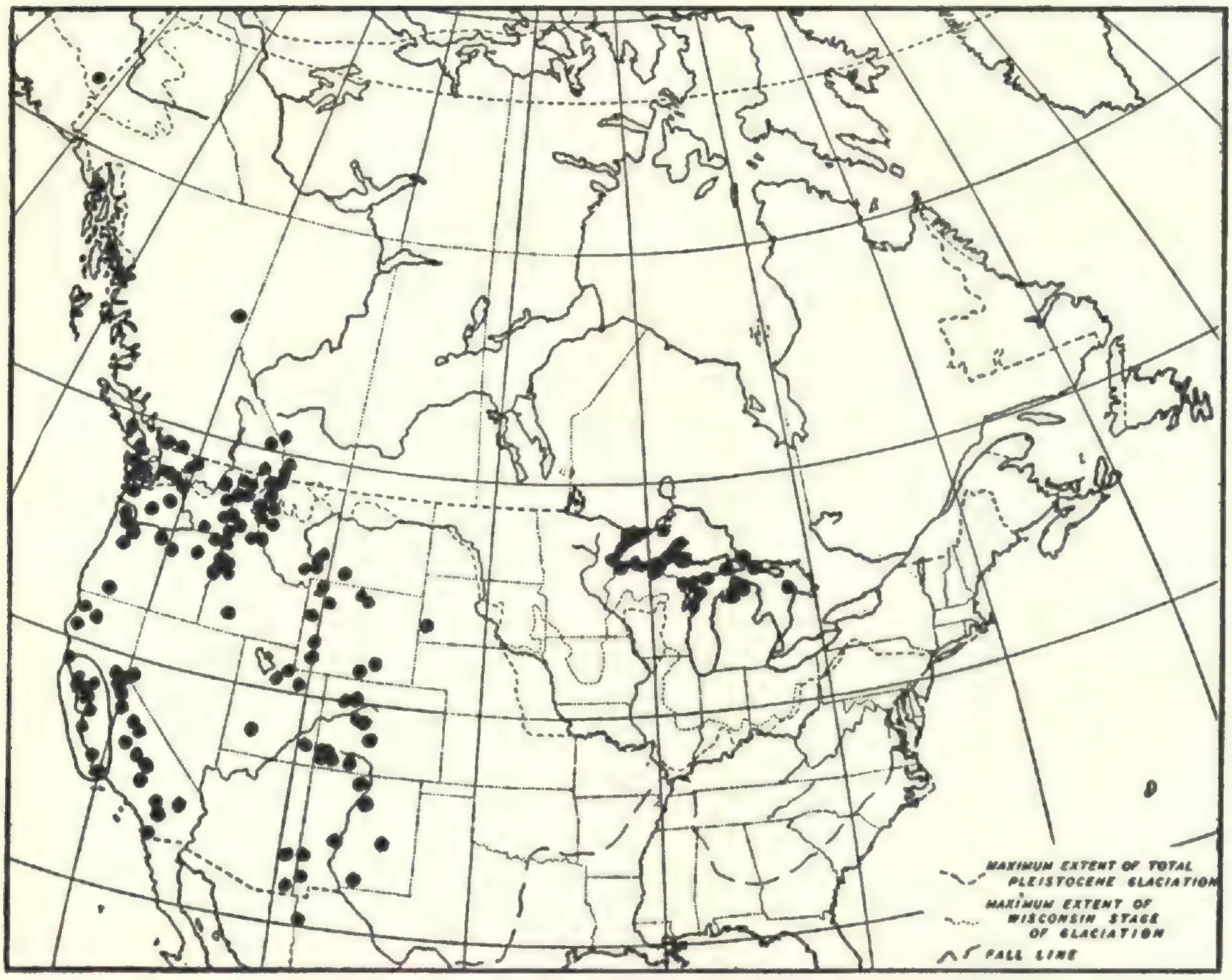
MAP 22

Stations about the Great Lakes where mass collections have been made (dots) grouped into regions (enclosed by ellipses). For explanation of pie-diagrams see caption under map 20. The figure below each pie-diagram indicates the number of individuals collected from that region.



MAP 23

Differences between regions about the Great Lakes, derived from map 22.



MAP 24

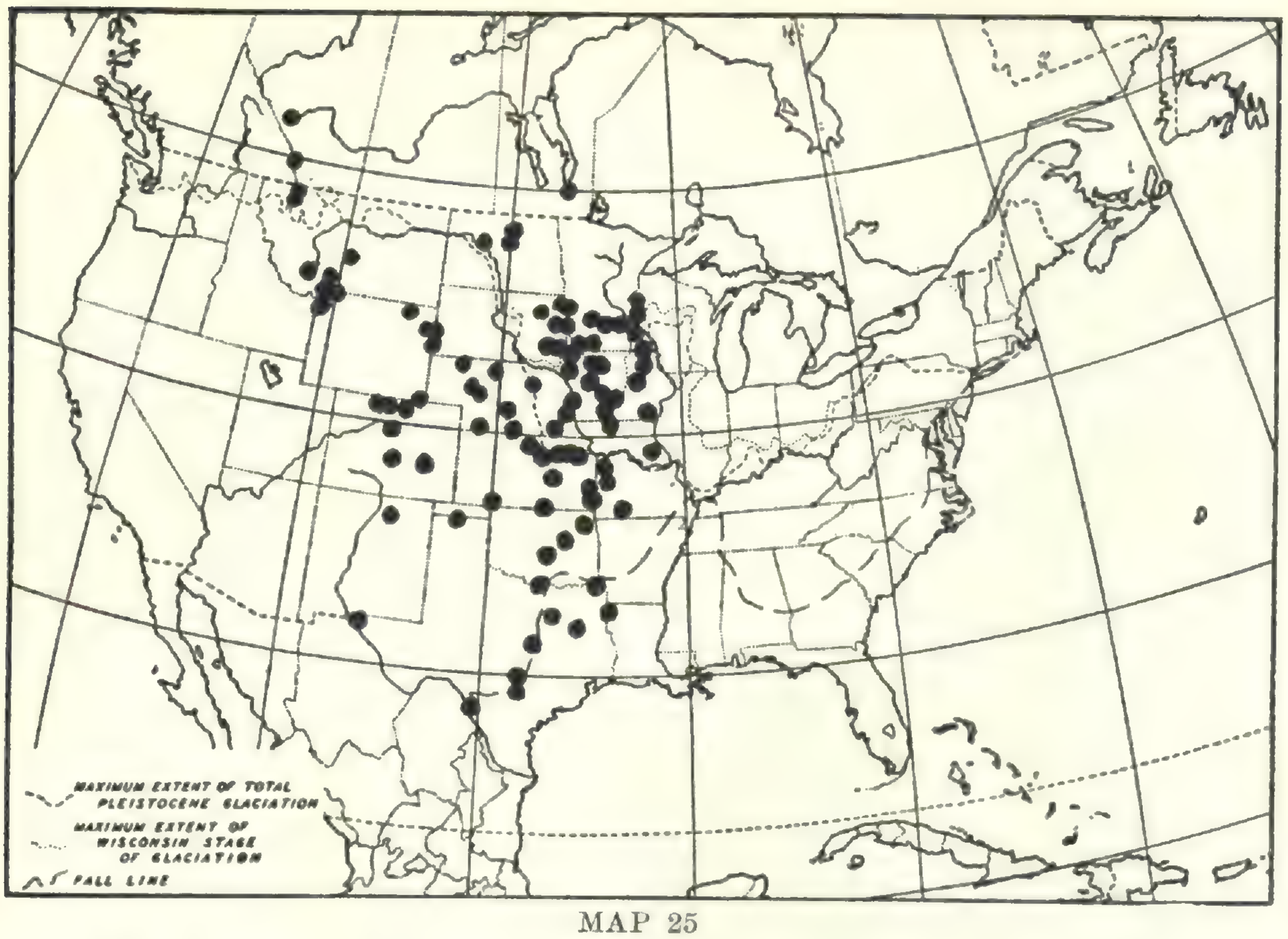
Range of *R. parviflorus*, and var. *velutinus* (in ellipse), from Fernald, *l.c.*, the Herbaria of the New York Botanical Garden, Pomona College, and the Universities of California and of Wisconsin, and letters from Drs. F. K. Butters and Hugh Raup. The base map is Hall's Outline Map, 205C, for maps 24, 25 & 26.

MAP 25

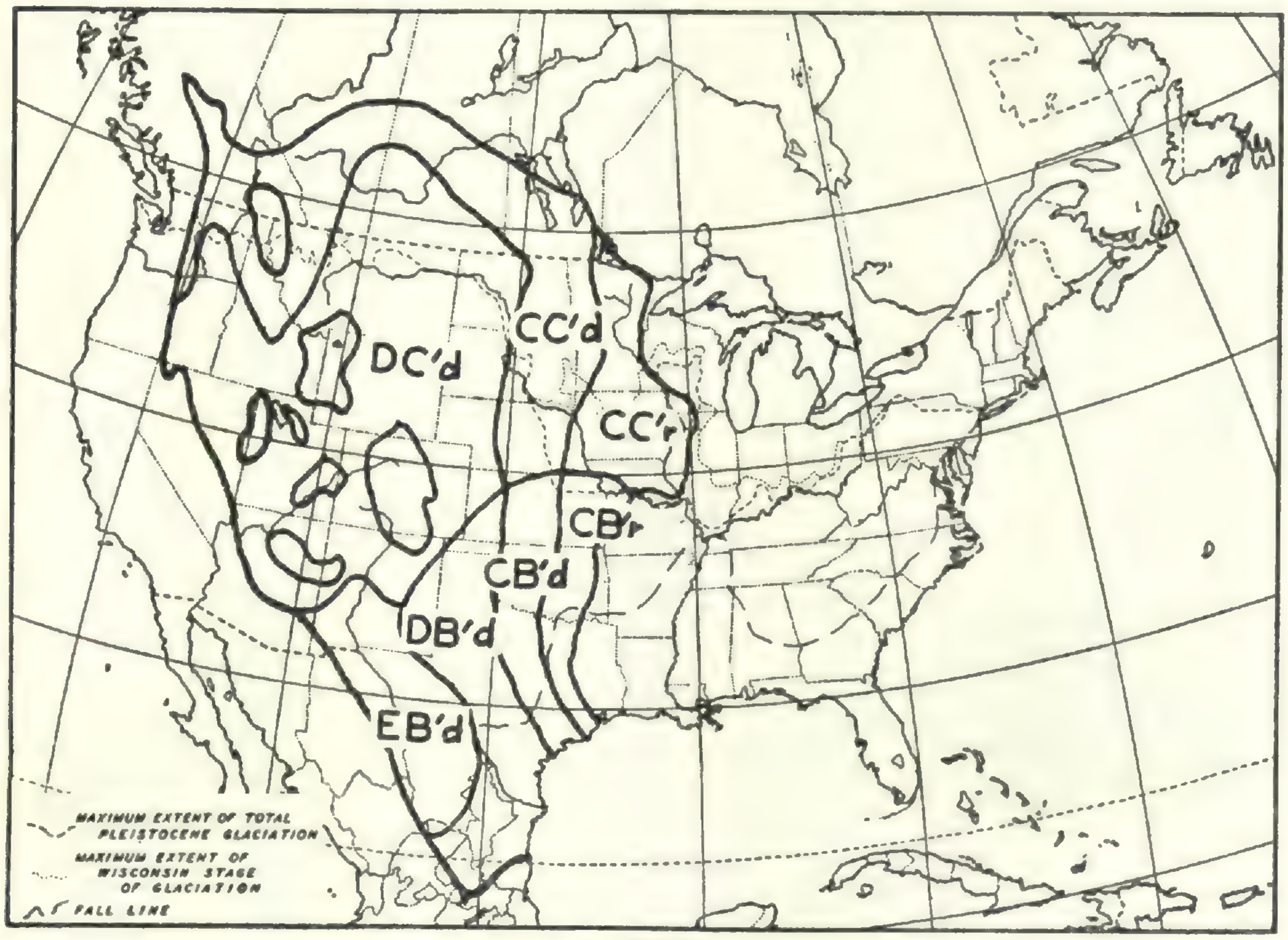
Range of *Astragalus caryocarpus*, from Fassett, 'Leguminous Plants of Wisconsin.'

MAP 26

The heavy lines enclose some of the climatic provinces described by Thornthwaite, Geogr. Rev. **21**, no. 4: *Pl. III;* the symbols describe the provinces as follows: C indicates subhumid, D, semiarid, and E, arid; B′ indicates mesothermal and C′ microthermal; r indicates precipitation adequate at all seasons, and d indicates precipitation deficient at all seasons.


MAXIMUM EXTENT OF TOTAL PLEISTOCENE GLACIATION
MAXIMUM EXTENT OF WISCONSIN STAGE OF GLACIATION
FALL LINE

MAP 25


DC'd
CC'd
CC'r
CB'r
CB'd
DB'd
EB'd
MAXIMUM EXTENT OF TOTAL PLEISTOCENE GLACIATION
MAXIMUM EXTENT OF WISCONSIN STAGE OF GLACIATION
FALL LINE

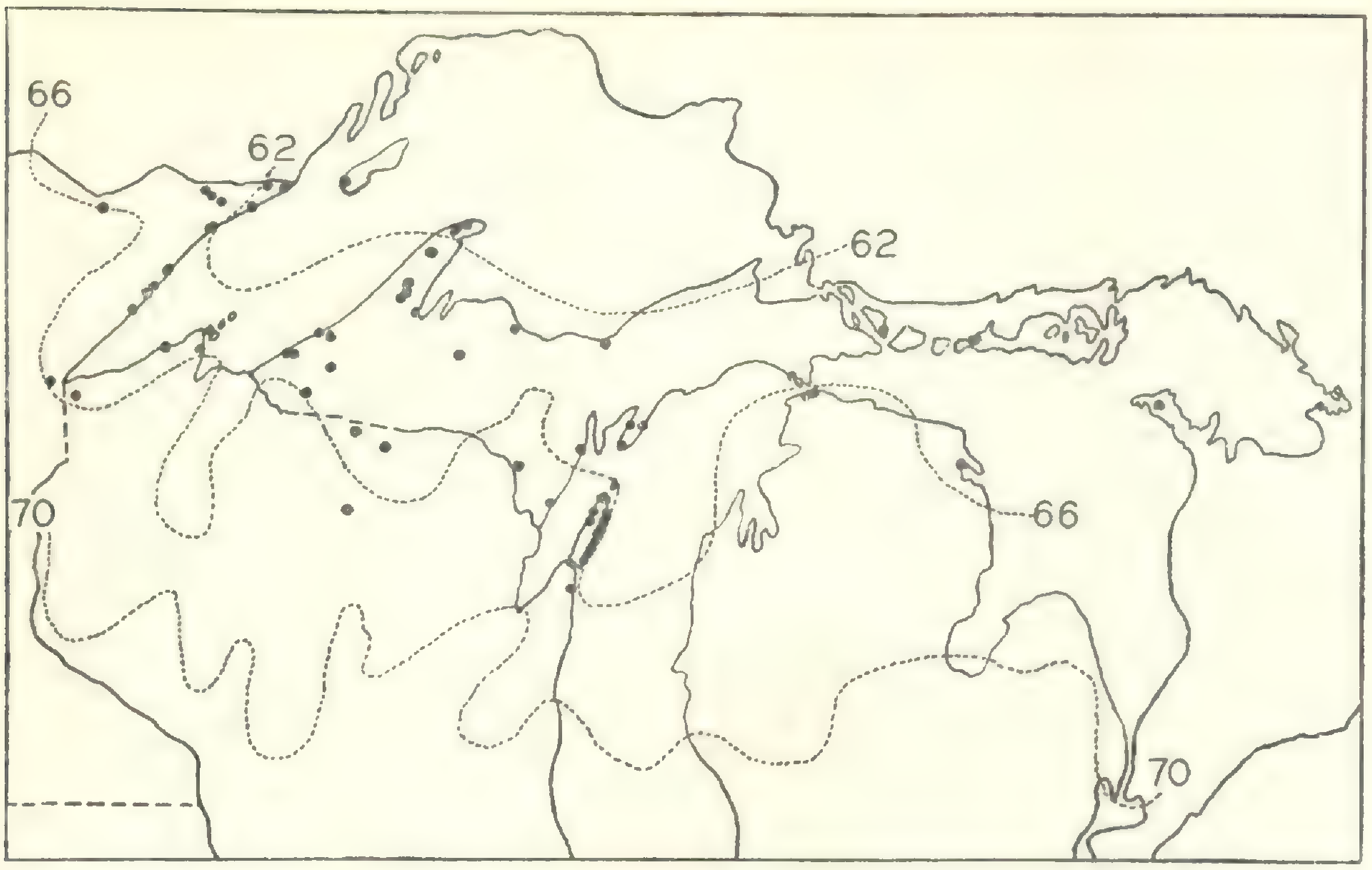
MAP 26

MAP 27

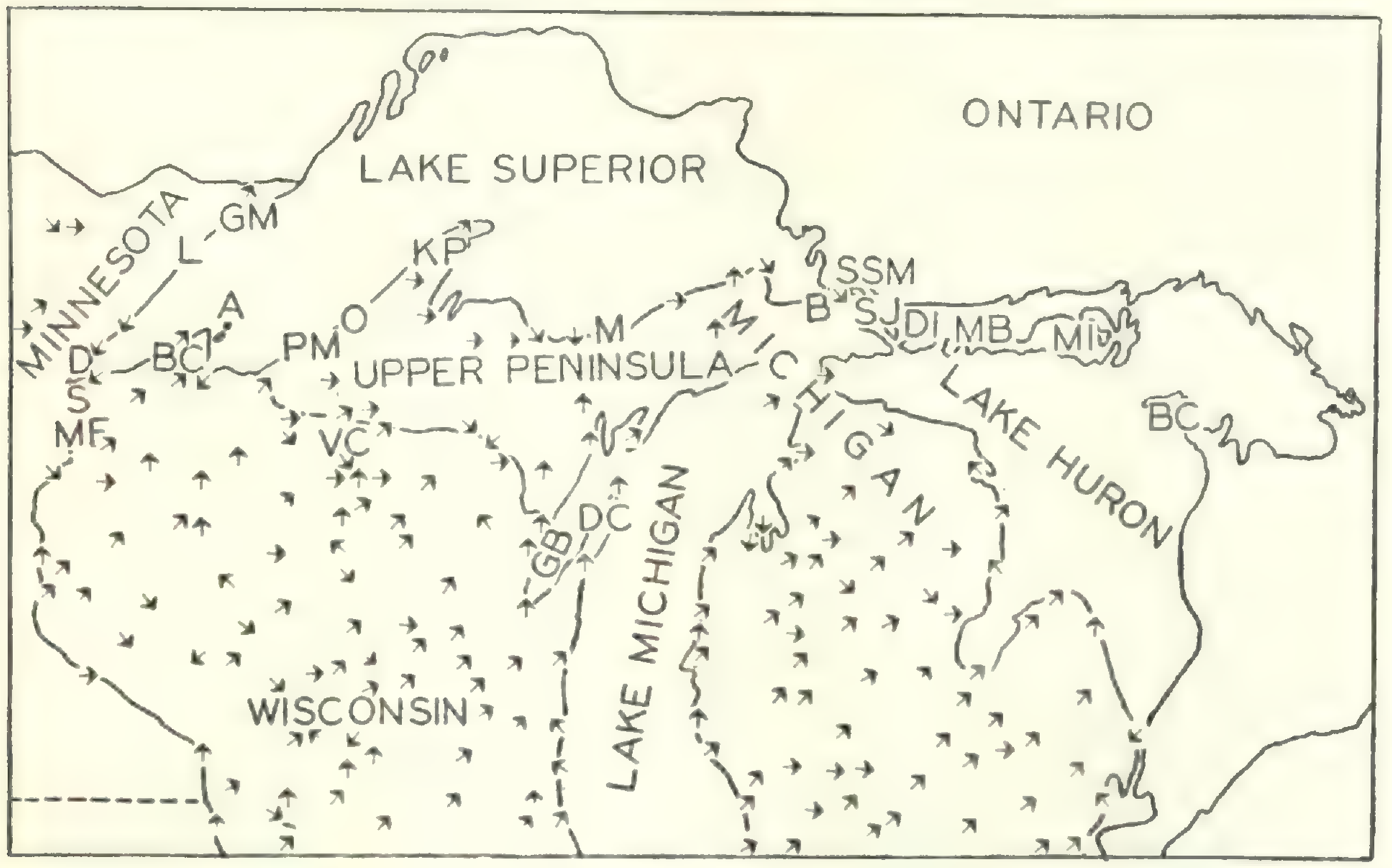
Dots: range of *R. parviflorus* in the Upper Great Lakes region. Dotted lines: isotherms for average temperatures for July, compiled from Sections 44, 45, 46, 47, 48, 49, 63, 64 & 65, "Climatic Summaries of the United States," published by the U. S. Weather Bureau.

MAP 28

Arrows show prevailing wind direction for July, compiled from "Climatic Summaries of the United States." Letters indicate places referred to in the text, as follows: A, Apostle Islands; B, Brimley; BC (in Canada), Bruce County; BC (in Wisconsin), Bayfield County; D, Duluth; DC, Door County; DI, Drummond Island; GB, Green Bay; GM, Grand Marais; KP, Keweenaw Point; L, Lutsen; M, Munising; MB, Meldrum Bay; MF, Manitou Falls; MI, Manitoulin Island; O, Ontonagan; PM, Porcupine Mountains; S, Superior; SJ, St. Joseph Island; SSM, Sault Ste. Marie; VC, Vilas County.


66
62
62
66
70
70

MAP 27


ONTARIO
LAKE SUPERIOR
MINNESOTA
L
GM
KP
O
A
D
BC
PM
M
SSM
B
SJ
DI
MB
MI
UPPER PENINSULA
MICHIGAN
LAKE HURON
BC
S
MF
VC
GB
DC
LAKE MICHIGAN
WISCONSIN

MAP 28

MAP 29

Range of *Populus balsamifera*, generalized from Munns, U. S. Dept. Agr. Misc. Publ. 287: 76. 1938. The base map is Hall's Outline Map, 205C, for maps 29–34.

MAP 30

Range of *Picea glauca*, generalized from Munns, *l.c.*, 35.

MAP 31

Range of *Arabis divaricarpa*, generalized from Hopkins, Rhodora **39**: 131. 1937.

MAP 32

Range of *Arabis Drummondi*, generalized from Hopkins, *l.c.*, 138.

MAP 33

North American range of *Botrychium Lunaria*, generalized from Clausen, Mem. Torr. Bot. Club **19**: 63. 1938.

MAP 34

Range of *Rubus parviflorus*, generalized from map 24 of this paper.

29

30

31

32

33

34

MAP 35

Range of *R. parviflorus* (solid black dots), *R. parviflorus* var. *velutinus* (half-black dots), and mixed colonies of the two (three-quarters-black dots), and their relation to topography in California and Nevada. Base map from Erwin Raisz in Atwood's 'Physiographic Provinces,' courtesy of Ginn & Co.

MAP 36

Relation of the range of *R. parviflorus* (dots) to topography in Wyoming, Colorado, and parts of adjacent states. Base map from Erwin Raisz in Atwood's 'Physiographic Provinces,' courtesy of Ginn & Co.

Explanation of Plate

PLATE 9

Fig. 1. Thimbleberry occurring in solid growth along a roadway, and as scattered plants in adjacent woods, near Toivola, Michigan. This patch contains at least three of the so-called varieties of this species.

Fig. 2. Thimbleberry growing in an old lumbering road near Lutsen, Minnesota. At least three of the so-called varieties of *R. parviflorus* occur in this patch.

1

2

EXPLANATION OF PLATE

PLATE 10

Fig. 3. Thimbleberry as a fence-row plant in Mohawk, Keweenaw County, Michigan.

Fig. 4. Thimbleberry in the gorge below Fish Creek Falls, Steamboat Springs, Colorado. This patch contains at least four of the so-called varieties of *R. parviflorus*.

3

4

EXPLANATION OF PLATE

PLATE 11

Fig. 5. Mouth of Little Cottonwood Canyon, Salt Lake City, Utah. Photograph by Prof. Walter Cottam, University of Utah.

Fig. 6. City Creek Canyon, Salt Lake City, Utah. Photograph by Prof. Walter Cottam, University of Utah.

5

6

EXPLANATION OF PLATE

PLATE 12

Fig. 7. Little Cottonwood Canyon, Salt Lake City, Utah. Photograph by Prof. Walter Cottam, University of Utah.

Annals
of the
Missouri Botanical Garden

Vol. 28 NOVEMBER, 1941 No. 4

DICHOPHYLLUM MOOREI AND CERTAIN ASSOCIATED SEEDS

HENRY N. ANDREWS

Instructor, Henry Shaw School of Botany of Washington University

A few years ago Elias (Moore et al., '36) described a flora from the Upper Carboniferous of east-central Kansas which contained certain elements such as *Walchia* and *Taeniopteris*, plants generally accepted as more typical of higher horizons. In many ways the most interesting and certainly the most novel member of the flora is the plant described as *Dichophyllum Moorei* (fig. 1). In the hope that a more detailed knowledge of it might shed light on the general problem of leaf morphology in the seed plants we visited the type locality in the summer of 1939 and made a small collection. Excavations carried on during the following summer yielded some excellent specimens, and although much remains to be known about this interesting fossil sufficient information has been obtained to warrant a short note on its gross morphology.

Occurrence of the Fossils.—

The locality from which both Elias' and our own specimens were obtained lies about six miles northwest of Garnett, Kansas (Section 32, T. 19S, R. 19E), which is in the Victory Junction member of the Stanton limestone and of Upper Carboniferous age. Its stratigraphy has been carefully worked out (Moore et al., '36), and despite the Permian aspect of the flora there seems to be no doubt that its age as given is correct.

Issued November 27, 1941.

Some difficulty attended collecting due to the indisposition of the owner on whose property the original quarry is located. It was found, however, that excellent material could be obtained only a few inches below the surface of the adjoining county road less than 100 yards from the quarry. For permission to dig in the road I wish to express my appreciation to Mr. Ray Hardin, Anderson County Road Commissioner.

Dichophyllum Moorei Elias.—

The appearance of this plant may best be gained from the restoration (fig. 1), as well as figs. 2 and 3 which served as the basis for fig. 1. In the most complete specimens the main axis is observed to break up near the distal end into two or three main branches which in turn divide, ultimately resulting in two or three subdivisions or telomes. Since there is no reason to believe that we are dealing with a fern the term pinnule will not be applied to these final subdivisions. It is significant to note that the plant possesses a well-developed cuticle, a point that supports the supposed xerophytic nature of the flora and suggests gymnospermous rather than filicinean affinities. Unfortunately the cellular details of the cuticle are poorly preserved, and macerations have proven of little value.

Lateral branches may be observed in fig. 3. These start to divide almost immediately in the same dichotomous fashion as the distal branches. It has been suggested by Jongmans (Moore et al., '36, p. 16) that these specimens are referable to *Callipteris flabellifera* (Weiss) Zeiller, but Elias has pointed out that "they differ distinctly chiefly by the character of the lateral pinna; in the species from Kansas they are palmate, while in the European form they are pinnate." I am entirely in agreement with Elias in making a generic distinction between *Callipteris* and *Dichophyllum*, but I believe that our specimens of the latter clearly reveal that they are not strictly palmate but rather present a combination of pinnate and dichotomous branching. In some specimens (fig. 6) the secondary branching at first glance appears to be palmate but it is evident from figs. 3, 4 and 7 that it is more in the nature of a uniform dichotomy, with never more than two or three terminal subdivisions arranged in a strictly palmate fashion.

A comparison of the specimens illustrated here with *Callipteris flabellifera* (Gothan, in Potonié, '07) reveals a rather sharp distinction in the mode of branching of the two, the frond of the latter being pinnately divided in contrast to the pinnate-dichotomous branch system of *Dichophyllum*.

The indirect evidence available shows that there is no reason to refer this plant to the Filicineae as its supposed inclusion in the genus *Callipteris* might suggest. The rather heavy cuticle and associated seeds (p. 379) point toward a gymnospermous plant. Although a further consideration of the affinities of *Dichophyllum* must be speculative certain comparisons are not without significance.

The fossil record has supplied a wealth of evidence which indicates that the leaf of modern ferns has been derived from a branch system which became confined to a single plane and progressively webbed. It is, moreover, highly probable that such a phylogenetic trend has resulted in the typical bilobed leaf of the modern *Ginkgo*. Although it is true that a single *Ginkgo* tree may harbor much foliar variation, chiefly in the degree of dissection of the lamina, the farther back we go in geologic time the more finely divided the leaves become until they pass over imperceptibly (at least as far as this character is concerned) into typical *Baiera* species. In *Baiera spectabilis* and *B. Lindleyana,* for example, there is little left that one can call a lamina. It seems likely that here, as with the ferns, a branch system has given rise to the lamina, and it is possible that we may partially bridge the gap between the "leaves" of the above-mentioned species of *Baiera* and a branch system proper through a form such as *Dichophyllum*. It must be emphasized that the latter is not postulated as a "missing link" in a direct line of development but rather as a representative stage in the transition of side branches to a leaf-like structure composed of petiole and blade.

The morphology of *Dichophyllum* is particularly interesting in the light of Mrs. Arber's recent ('41) interpretation of leaf and stem in the angiosperms. The mode of branching that is found in *Dichophyllum* and *Psygmophyllum,* as well as certain of the better-known Coenopterid ferns, adds weight to her

conception of the *shoot* as the basic unit of plant structure. In so far as we know these forms, it is not possible to relegate their branch system to the classical categories of stem or leaf, and it is probable that the term shoot will be a generally acceptable one.

Mrs. Arber's concepts are not concerned with phylogeny. She specifically states: "This view has no phylogenetic implications; it does not commit us to any opinion as to the origin of the leaf as a matter of history, but is concerned with what the leaf actually *is*, here and now." It seems legitimate, however, to expand this concept to include certain apparent phylogenetic possibilities. A comparison of a long shoot of *Ginkgo biloba* with the shoot of *Dichophyllum* as restored in fig. 1 reveals a striking similarity in basic structure. The dichotomous side branches of the latter may well be the forerunners of the deeply dissected Baieras which in all probability are ancestral forms of the modern *Ginkgo*.

The closest affinities of *Dichophyllum* seem to lie with certain species of the genus *Psygmophyllum*, especially *P. cuneifolium*. There is, however, considerable variation in *Psygmophyllum*, and it is perhaps doubtful whether it constitutes a natural assemblage of species. Whether this be so or not the species included in that genus strongly suggest that leaves as they appear in *P. Kidstoni* may have had their origin from such forms as *P. cuneifolium*, where we find a branch system not unlike *Dichophyllum*, through *P. Grasserti* with its deeply dissected "leaves." (For a more detailed description of *Psygmophyllum* see Seward, '19, p. 79–90).

Associated Seeds.—

At least four or five species of seeds occur with the other plant remains at Garnett.[1] Of these one is of particular interest because of its abundance, its frequent association with

[1] The large number of clearly defined and apparently new seed species found here is of considerable interest. Some certainly belong to the coniferous remains, while others are probably referable to the pteridosperms or other gymnospermous groups. It is proposed to include a detailed consideration of these seeds at a later date in a general revision of American Carboniferous seed impressions and compressions.

Dichophyllum and its various features which set it apart as generically distinct from anything previously described.

The seed in question is characterized by two prominent horn-like projections at the micropylar end (figs. 8, 9, 10) and appears to be comparable with that figured by Elias as *Samaropsis* n. sp. B. However, according to the accepted concept of *Samaropsis* (Seward, '17, pp. 348–354), that genus is distinctly winged while our specimens show no semblance of a wing. Because of this disagreement and since they do not conform to any described genus it is proposed to assign to them a new binomial.

Diceratosperma Carpenteriana gen. et sp. nov.—

Samaropsis n. sp. B. Elias, in Moore, Elias and Newell, A "Permian" flora from the Pennsylvanian rocks of Kansas. Jour. Geol. **44**: 12, *fig. 7(5)*. 1936.

Seeds, presumably platyspermic, 6.0–8.0 mm. long, 3.5–4.0 mm. broad. Two prominent horns, approximately one third as long as body of seed, at micropylar end. Presence of pollen chamber indicated by papilla-like cast between horns.

Locality: six miles northwest of Garnett, Kansas: Section 32, T. 19S, R. 19E. Horizon: Victory Junction member of the Stanton Limestone, Missouri Series. Age: Upper Carboniferous. The species is named in honor of Mr. A. C. Carpenter of Ottawa, Kansas, whose knowledge of the local geology and willing cooperation greatly facilitated my collecting.

Acknowledgment.—

I am indebted to Dr. M. K. Elias for placing unpublished photographs of *Dichophyllum* at my disposal and for helpful suggestions concerning the Garnett flora.

Literature cited.—

Arber, A. (1941). The interpretation of leaf and root in the angiosperms. Biol. Rev. **16**: 81–105.

Moore, R. C., M. K. Elias, and N. D. Newell (1936). A "Permian" flora from the Pennsylvanian rocks of Kansas. Jour. Geol. **44**: 1–31.

Potonié, H. (1907). Abbildungen und Beschreibungen fossiler Pflanzen-Reste. Lief. 5: 64. Herausg. Konig. Preuss. Geol. Landes. u. Bergakad.

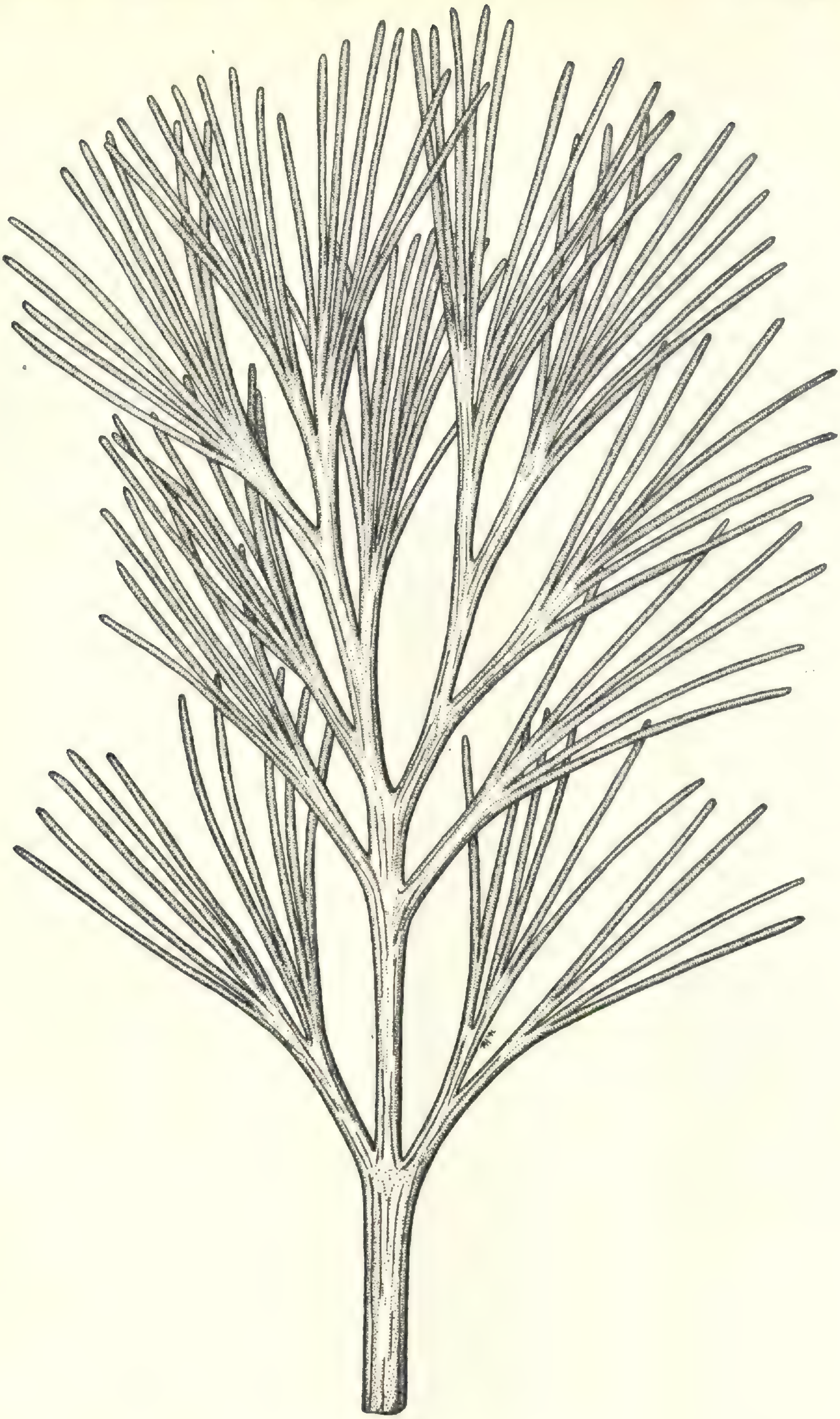
Seward, A. C. (1917). Fossil Plants. III. Cambridge.

————. (1919). Fossil Plants. IV. Cambridge.

Explanation of Plate

PLATE 13

Fig. 1. Restoration of *Dichophyllum Moorei* Elias.



1

ANDREWS—DICHOPHYLLUM MOOREI

Explanation of Plate

PLATE 14

Dichophyllum Moorei Elias

Fig. 2, No. 1432, × .5; fig. 3, No. 1433, × .5; fig. 4, No. 993, × .6; fig. 5, No. 1227, × .6; fig. 6, No. 1428, × 1.

ANDREWS—DICHOPHYLLUM MOOREI

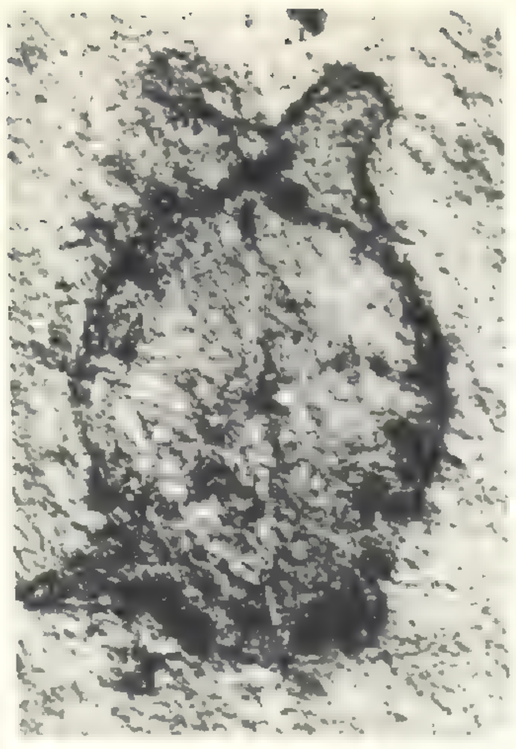
EXPLANATION OF PLATE

PLATE 15

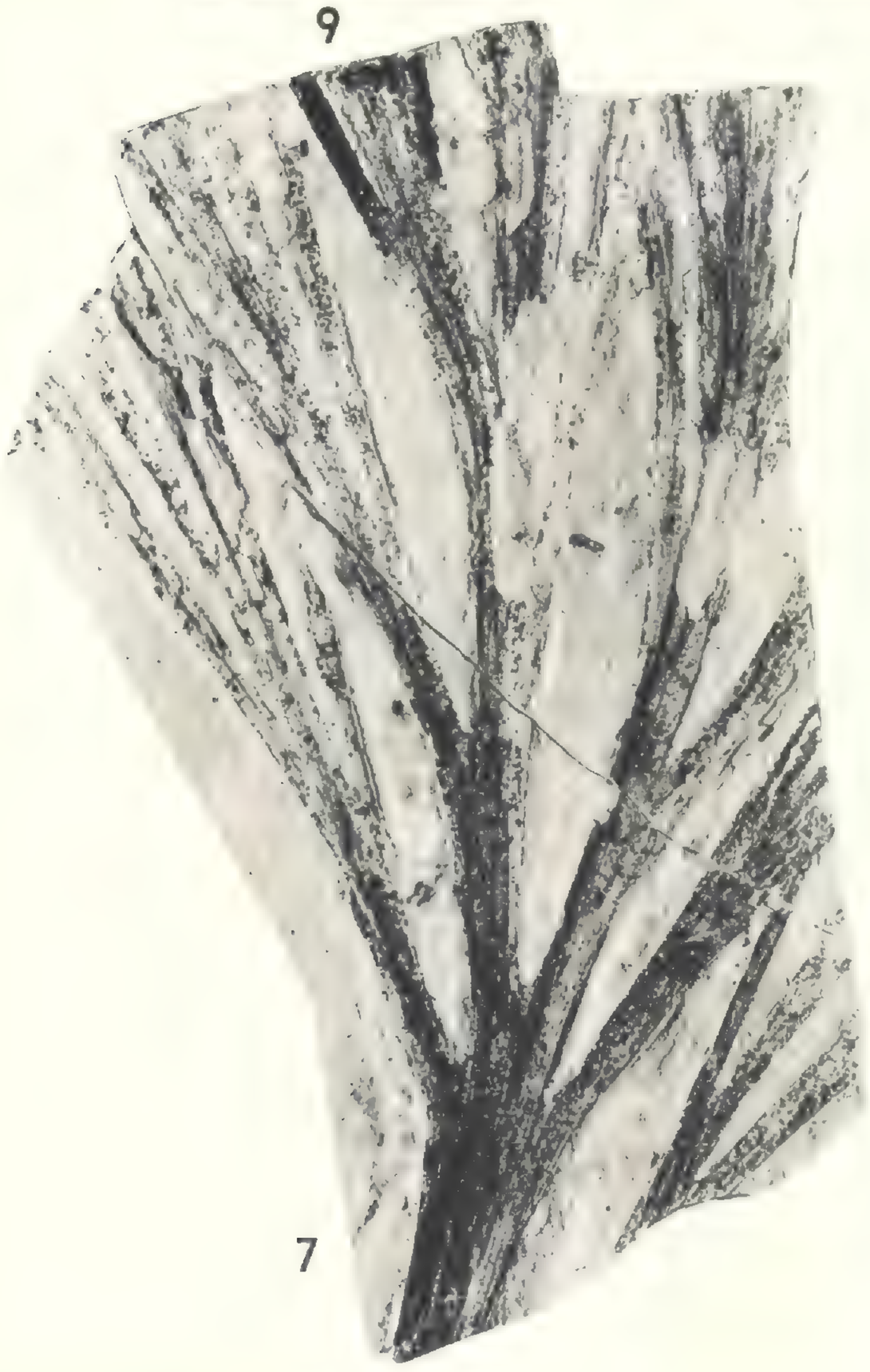
Fig. 7. *Dichophyllum Moorei*, No. 1425, × 1.

Figs. 8, 9, 10. *Diceratosperma Carpenteriana*, Nos. 1434, 1435, 1436 respectively, all × 6.3.

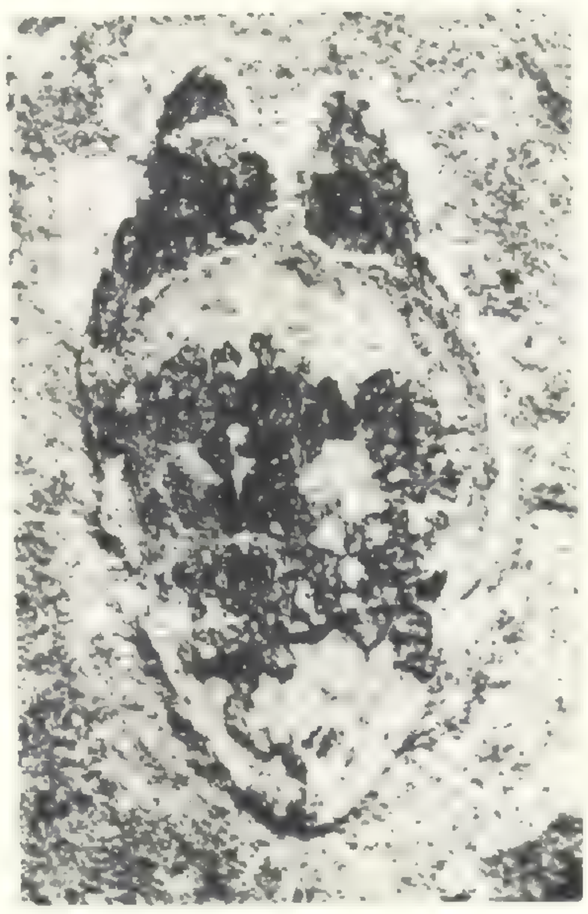
9



10



7



8

ANDREWS — DICHOPHYLLUM MOOREI

A REVISION OF THE NORTH AMERICAN SPECIES OF THE GENUS ANISACANTHUS[1]

STANLEY HARLAN HAGEN

Formerly Assistant in the Henry Shaw School of Botany of Washington University

Introduction

Anisacanthus is a small genus of the Acanthaceae, which, because of the relatively few collections and the obscure specific characters, has been poorly understood. The present study was undertaken to correlate the morphological characters of the taxonomic entities of the genus as a whole, and to determine the relative value of the different characters in specific and varietal delimitation.

Anisacanthus is one of several genera segregated from *Justicia,* having been described by Nees[2] in the year 1842. He based it on *Justicia quadrifida* Vahl,[3] which in turn was founded on *J. coccinea* Cavanilles,[4] a plant grown in the gardens of Madrid from stock brought from Mexico probably in the latter part of the eighteenth century. Vahl had changed the species name from *coccinea* to *quadrifida* because of the earlier *J. coccinea* Aublet. Under the name *Justicia quadrifida* Vahl, it was not infrequently cultivated in European gardens; and fortunately several authentic specimens from horticulture have been preserved in herbaria. Nees, however, soon changed the name of the type species to *Anisacanthus virgularis* (Salisbury) Nees,[5] and as such it was known until Standley revived the specific name *quadrifidus*.[6]

[1] An investigation carried out in the Graduate Laboratory of the Henry Shaw School of Botany of Washington University and submitted as a thesis in partial fulfillment of the requirements for the degree of master of science in the Henry Shaw School of Botany of Washington University.

[2] Nees ab Esenbeck, C. G. Linnaea **16**: 307. 1842.

[3] Vahl, M. Enum. Pl. **1**: 124. 1805.

[4] Cavanilles, A. J. Icon. et Descr. Pl. **2**: 77, *pl. 199*. 1793.

[5] Nees in DC. Prodr. **11**: 445. 1847.

[6] Standley, P. C., Contr. U. S. Nat. Herb. **23**: 1343. 1926.

Issued November 27, 1941.

Three of the species of *Anisacanthus* have been segregated from other genera. Nees transferred *A. pumilus* from *Justicia*, and Gray removed *A. Wrightii* and *A. Thurberi* from *Drejera*. *A. insignis*, *A. abditus*, *A. Gonzalezii*, and *A. tulensis* have been described from collections of later explorations.

Grateful acknowledgment is made to Dr. George T. Moore, Director, for placing at the author's disposal the splendid facilities for study offered by the Missouri Botanical Garden, and Dr. J. M. Greenman, Curator of the Herbarium, for his guidance during the study and for securing loans of materials needed. The author also appreciates the helpful cooperation of the librarians, and the constructive criticism offered by other members of the staff.

General Morphology

Stems.—The genus *Anisacanthus* consists of suffruticose plants, varying from erect to prostrate in habit, and mostly less than a meter in height or length. The wood is tan or brown in color, evenly grained, soft and brittle to relatively hard. The bark of the upper branches is thin, fibrous, rather brittle, exfoliating in longitudinal strips; on the lower branches it is gray, and relatively fine-grained. Stem pubescence is mostly confined to two opposite longitudinal strips continuous with the base of the petioles. The stem is terete, usually minutely fluted or striate.

Leaves.—The leaves vary considerably on a single plant, but within fairly consistent ranges throughout the group. The mature leaves are usually lanceolate-acuminate with acute or obtuse bases, but sometimes with broader and cordate bases. In one species, *A. insignis*, the linear and sessile leaf-characters serve as a basis for segregating the variety *linearis*. Dietrich, in describing *Justicia pumila*, mentioned the fact that the base of the leaf-blade was somewhat oblique. This character is not confined to that one species, however, but is infrequently found in others. Cystoliths are usually noticeable on the upper surface, especially if the leaf is glabrous. Punctate

glands on the lower surface are also characteristic of the group. Pubescence, when present, is mostly of short hairs thinly scattered over the surface or limited to few hairs along the veins, midrib, and petiole.

Inflorescence.—The inflorescence is of the indeterminate class. It may be a spike, raceme, or a panicle; in some cases the spike may be secund. If paniculate, the axis is usually shortened so that the cluster of flowers appears more like a head than a panicle. Considerable variation may be observed in the nature of the inflorescence, such as a secund spike with a single flower at a node, two opposite axillary flowers at a node, flowers 2 or 3 in each axil, an open or a shortened panicle. While a particular form of inflorescence is characteristic for certain species, there is usually some variation, even on the same plant.

The bracts are usually sessile, more or less triangular, acute, with the same general sort of pubescence as that of the calyx and the pedicel. Bracteoles are smaller, but similar in form. Both bracts and bracteoles are usually caducous, but may persist until the flower is fairly mature.

Calyx.—The calyx furnishes the more important characters in specific delimitation. These characters are quite consistent and easily distinguished with a lens. One of the striking features is the type of pubescence; with the exception of *A. Gonzalezii,* which is essentially glabrous, the surface is covered either with pilose or glandular hairs, or even with sessile glands. There may be some hairs present with the glands, but one type or the other is dominant. The glandular hairs are usually stipitate, the stipe cells being hyaline and the secretory cell at the tip brown. In one or two species the glands are reduced, sessile, and merge into puberulence. In *A. quadrifidus* and *A. Wrightii,* the calyx is sessile or only very shortly pedicellate. The calyx-lobes range in size from shallow ones 1–2 mm. long, as in *A. Wrightii,* to the tentacular and subulate ones, 2 cm. long, as in *A. Thurberi.* All measurements were taken from calyces in fruit or full flower, as the calyx is accrescent.

Corolla.—When Nees segregated *Anisacanthus* from *Justicia* he described the corolla as having an entire posterior lip. However, earlier workers were correct in describing the lip as slightly emarginate; both types occur and variations may be found on the same plant. The corolla is tubular or funnel-shaped, more or less curved, with spreading, recurved, ligulate to elliptical lobes. The mature corolla is from 3½ cm. in length, with the lobes usually about as long as the tube. The total length, the length of the tube and lobes, and relative ampliation at the throat are of importance in specific delimitation. The corolla is usually bright red and thinly covered with short, pilose, red hairs. In only one species, *A. abditus,* is the corolla glabrous.

Stamens.—The stamens are inserted on the corolla-tube, alternate with the lobes and usually near the base of the central lobe of the 3-parted anterior lip. The filaments are highly colored and vary in length with the corolla-lobes, seeming to extend to the tips of the lobes. The anther-sacs of *Anisacanthus* are essentially parallel, equal, and inserted at the same height on the filament; these characters are key characters in generic delimitation. The filament is attached at the base of the connective which joins the sacs from about half to two-thirds of the length from the top.

Pistil.—The ovary is partly surrounded at the base by a disc. The style is filiform, as long as the corolla, and terminates in a slightly enlarged 2-lobed stigma. The characters of the ovary, style, and stigma are essentially the same for all species, and thus of little taxonomic importance.

Fruit.—The capsule is generally uniform throughout the genus, but in a few cases it presents characters of taxonomic value. It is typically a subglobose, 2-celled body and a relatively distinct stipe of more or less equal length. In *A. Gonzalezii* the body is not separated from the stipe by a noticeable constriction, but gradually tapers to the base. The seeds are 2 to 4 in number and are usually nearly parallel and opposite in the capsule. They vary only slightly within the genus, being

more or less discoid, tuberculate and shiny, and held upright at maturity by curved retinacula.

Generic Relationships

Anisacanthus is a member of the tribe Justicieae and the subtribe Eujusticieae which is usually placed near the end of the family. The tribe includes plants with a 2-lipped corolla, 2–4 stamens with 1–2-locular anthers. As regards other members of the tribe, the genus appears to be closest to *Carlowrightia.* However, *Anisacanthus* has a much larger calyx, corolla, and fruit; and the corolla is 2-lipped (3 plus 1 lobes), whereas in *Carlowrightia* it is about equally 4-parted. *Anisacanthus* is a much larger plant than *Carlowrightia* and, so far as known, contains no herbaceous species as does *Carlowrightia.* It appears to be fairly closely related to *Chileranthemum* and *Odontonema,* but is probably more advanced than these genera, since it lacks staminodia which they possess. Mucronate appendages at the base of the anther sacs are wanting in *Anisacanthus;* by this character alone it may be distinguished from *Justicia.* Also the anther-sacs are less equal and more oblique in *Justicia. Anisacanthus* also has been confused with *Beloperone,* but this genus has mucronate appendages on the anther-sacs and is more closely allied to *Justicia.* Moreover, *Anisacanthus* is quite closely related to *Jacobinia* with which it has been frequently confused. They both lack the appendages on the base of the anther-sacs, but the equal and parallel anther-sacs of *Anisacanthus* readily distinguish it from *Jacobinia.*

Relationship of the Species

While the author has not divided the genus *Anisacanthus* into subgenera or sections, there are certain groups of species which are more closely related to each other than to others.

From the calyx alone it is evident that *A. pumilus* shows closest relationship to *A. tulensis,* the main difference being in size (pl. 17, l and m). The relationship is also indicated by the

slender, ligulate-lobed corolla, and by the consistent number of 4 seeds in the capsules of both species.

Similarly, the calyx of *A. Thurberi* appears to be an exaggerated form of that of *A. insignis* (pl. 17, i and h). However, these two species are not as closely related as are *A. tulensis* and *A. pumila.* The size and proportions of the corolla parts differ, and the seed number is not consistent in *A. insignis.*

The type species, *A. quadrifidus,* seems closest to *A. Wrightii.* The calyx is quite similar, although differing in proportions (pl. 17, f, g, and j). As a matter of fact, the more deeply cleft calyx form in *A. Wrightii,* which is found generally in plants of the area between the two species, was first described as *A. junceus* and later placed in synonymy under *A. quadrifidus.* The size and form of the corolla and the characteristic secund spicate inflorescence give additional evidence of the relationship.

Although the calyx of *Anisacanthus abditus* somewhat resembles that of *A. quadrifidus* (pl. 17, k), several characters segregate it from all the other species. The large bracts, the nature and extent of the glandular pubescence, and the proportions of the corolla are all peculiar to this species. Also, the capsule is smaller than is usual in the genus.

Another distinct species is *A. Gonzalezii,* its cylindrical glabrous calyx-tube and ciliate calyx-lobes being different from those of every other species (pl. 17, n). The capsule characters are also unique in the genus (pl. 17, b), although the seed arrangement somewhat resembles that in *A. abditus.*

Geographical Distribution

The species of *Anisacanthus* are semi-xerophytic, usually growing on exposed, rocky slopes within a range confined almost entirely to Mexico. The center of distribution appears to be in southern Mexico, in the general region of Puebla, Oaxaca, Morelos, and the state of Mexico. Migration seems to have been mainly northward. Only three entities, *A. insignis* var. *linearis, A. Thurberi,* and *A. Wrightii,* extend into the United States. Representatives of the genus are found

throughout Mexico, however, and it may be anticipated that further collections will extend the present known ranges. The ranges of the species in the southern part of Mexico around the main center of distribution overlap somewhat, whereas the northern species are more distinct. There seems to be a small secondary center of distribution in the Sonoran region

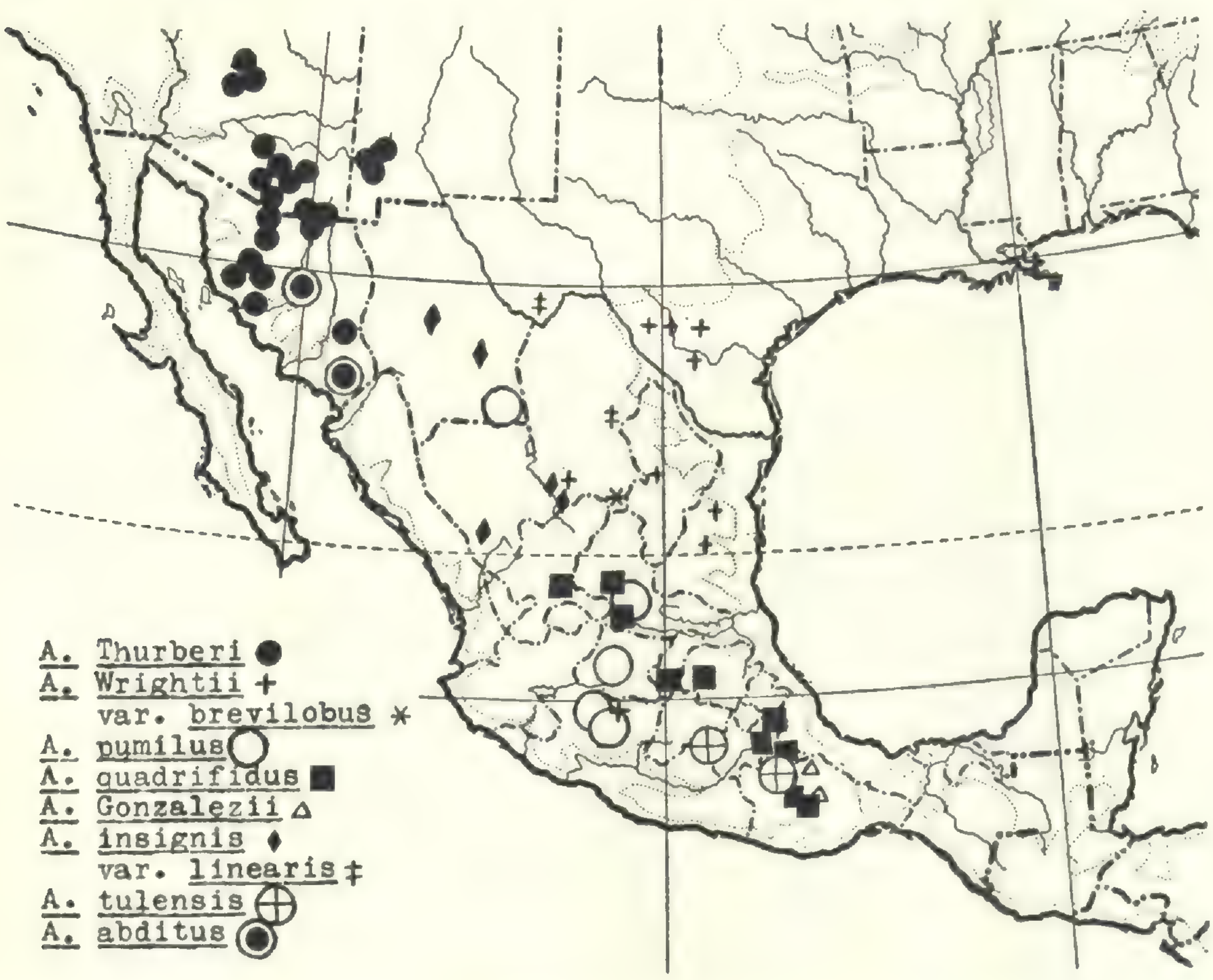


Fig. 1. The geographical distribution of the species of *Anisacanthus* in North America.

which shows a northerly migration with one species extending into Arizona and southwestern New Mexico. It is interesting to note the regions where *Anisacanthus* is absent; with the exception of the two Sonoran species one might say that it is not found on the coastal slopes or lowlands. In general, the plants of this genus are characteristic of the mountainous region of southern Mexico and the high central plateau extending northward (fig. 1).

ABBREVIATIONS

The herbaria from which material was obtained for study and from which specimens have been cited are indicated by the following abbreviations:

C = University of California, Berkeley.
F = Field Museum of Natural History, Chicago.
M = Missouri Botanical Garden, St. Louis.
NY = New York Botanical Garden.

TAXONOMY

Anisacanthus Nees in Linnaea **16**: 307. 1842; in DC. Prodr. **11**: 445. 1847; Bentham. & Hooker, Gen. Pl. **2**: 1117. 1873; Gray, Syn. Fl. N. Am. **2**^{1}: 326. 1878, and ed. 2, **2**^{1}: 457. 1886; Engler & Prantl, Die Natürl. Pflanzenf. **4**^{3b}: 327–328. 1895; Standley in Contr. U. S. Nat. Herb. [Trees and Shrubs of Mexico] **23**: 1342–1343. 1926.

Branched shrubs, mostly about 1 m. high; stems terete, more or less minutely striate, younger branches usually pubescent in two opposite lines continuous with the base of the petioles, older stems covered with brown or gray bark exfoliating in thin strips; leaves opposite, petiolate or sessile, lanceolate to linear, punctate, cystoliths common on the upper surface; inflorescence spicate, racemose or paniculate, flowers borne singly or several at a node, secund or opposite; bracts and bracteoles mostly triangular to linear, usually caducous, agreeing with the calyx in pubescence; calyx subequally 5-lobed, lobes triangular to linear-acuminate, pubescent to glabrous; corolla usually red, mostly pilose, tubular to funnel-shaped, more or less arcuate, somewhat inflated at the base around the ovary, 2-lipped, usually recurved, the posterior lip entire or slightly emarginate, the anterior lip 3-lobed; stamens 2, epipetalous anteriorally, usually at the base of the central lobe and alternate with the corolla-lobes, filaments more or less thick and fleshy, colored, glabrous, anthers 2-celled, subequal, inserted at the same level or nearly so, parallel or slightly divergent at the base, connected to the middle or slightly below,

non-mucronate or appendaged; style filiform, glabrous, about as long as the corolla, stigma simple, 2-lobed; fruit a subpyriform capsule, slightly beaked, usually narrowed at the base to form a relatively distinct stipe, glabrous and shiny; seeds 2–4, discoid, more or less tuberculate, each supported by a curved retinaculum usually at about the same height in the body of the capsule.

Type species: **Anisacanthus quadrifidus** (Vahl) Nees in Linnaea **16**: 307. 1842.

KEY TO THE SPECIES

A. Bracts of the inflorescence foliaceous, obscuring the calyx; entire surface of the plant glandular, at least in the younger stages.....*1. A. abditus*

AA. Bracts of the inflorescence neither foliaceous nor obscuring the calyx; glands, when present, confined to the inflorescence.

B. Calyx glabrous or nearly so except for the hirsute-ciliate lobes, not glandular.....*2. A. Gonzalezii*

BB. Calyx distinctly glandular, the lobes not hirsute-ciliate.

C. Corolla 4–5 cm. long.

D. Leaves petiolate, linear-lanceolate to lanceolate, pilose to hispid .....*3. A. insignis*

DD. Leaves sessile, linear to linear-lanceolate, essentially glabrous .....*3a. A. insignis* var. *linearis*

CC. Corolla 3–4 cm. long.

D. Calyx 9–20 mm. long; stamens epipetalous below sinuses of anterior lip.....*4. A. Thurberi*

DD. Calyx 5–10 mm. long; stamens epipetalous at sinuses of anterior lip.

E. Calyx mostly 7–10 mm. long; lobes 5–6 mm. long, attenuate .....*5. A. quadrifidus*

EE. Calyx mostly 5 mm. long; lobes 1–3 mm. long, more or less acute, not alternate.

F. Calyx-tube equal to or shorter than the lobes.....*6. A. Wrightii*

FF. Calyx-tube much longer than the lobes.....*6a. A. Wrightii* var. *brevilobus*

BBB. Calyx pubescent, not glandular; the lobes not hirsute-ciliate.

C. Ultimate branches pubescent in lines; calyx 7–12 mm. long.....*7. A. pumilus*

CC. Ultimate branches evenly pubescent over entire surface; calyx 10–14 mm. long.....*8. A. tulensis*

1. A. abditus Brandg. in Zoe **3**: 348–349. 1893; Standl. in Contr. U. S. Nat. Herb. **23**: 1342. 1926.

Shrubs about 1–2 m. high, more or less glabrous-pubescent

throughout; leaves ovate to lanceolate, 1–6 cm. long, 0.5–3 cm. broad, petioles slender, 0.5–2.5 cm. long; bracts of the inflorescence quite distinct from the upper leaves, sessile, ovate to obspatulate, obtuse, about 1 cm. long, 4–5 mm. broad; inflorescence a terminal or lateral spike; calyx obscured by the subtending bracts, 5–7 mm. long, rather thin and delicate, deeply 5-cleft, lobes lance-attenuate; corolla 3–4 cm. long, glabrous, tubular, the 4 lobes subequal, shorter than the tube, 5 mm. broad, ovate; filaments alternate, attached near the base of the central anterior lobe, 7–9 mm. long, anthers 3 mm. long, sacs connected to below the middle; ovary extending about 1 mm. above the disc; capsule 1 cm. long, about 3 mm. in diameter, the body more or less oblong, slightly longer than the stipe; seeds 4, 2–3 mm. in diameter, tuberculate, one pair borne obliquely about 2 mm. above the other.

DISTRIBUTION: mountainous region of central Sonora, Mexico.

MEXICO: SONORA: Las Durasnillas, May 14, 1892, *Brandegee s.n.* (C TYPE, F); vicinity of Alamos, March, 1910, *Rose, Standley & Russell s.n.* (F); Caramechi, Rio Mayo, Dec. 3–10, 1934, *Gentry 1178* (F, NY, M).

2. A. Gonzalezii Greenm. in Proc. Am. Acad. **39**: 89. 1903; Standl. in Contr. U. S. Nat. Herb. **23**: 1342. 1926.

Suffruticose; stems uniformly pubescent; leaves ovate-lanceolate to linear-lanceolate, 1.5–4 cm. long, 4–17 mm. broad, puberulent or often slightly pubescent above, pilose below, petioles 1–5 mm. long, pubescent; inflorescence spicate, flowers 1–2 in each axil, sessile; bracts linear to linear-lanceolate, 0.5–2 cm. long, 1–3 mm. broad, finely pubescent, ciliate; calyx 5–11 mm. long, tube cylindrical, glabrous, lobes lance-attenuate, hirsute-ciliate, about as long as the tube; corolla 3.5–4 cm. long, slightly infundibuliform, posterior lip emarginate, lobes about one-third total length of the corolla, ligulate, slightly recurved; stamens attached near the base of the anterior lip and alternate with the lobes, filaments 11–13 mm. long, anther-sacs 4 mm. long, parallel, connected to below the middle; ovary extending about 1.5 mm. above the disc; capsule 16–19 mm. long, 3–4 mm. in diameter, gradually tapering to the base; seeds 4, 3–4 mm. in diameter, one pair borne obliquely above the other.

DISTRIBUTION: central and northern Oaxaca, Mexico.

MEXICO: OAXACA: Las Naranjas, Aug., 1908, *Purpus 3018* (C), and *3041* (F, M, NY).

3. A. insignis Gray, Syn. Fl. N. Am. ed. 2, **2**[1]: 457. 1886; Standl. in Contr. U. S. Nat. Herb. **23**: 1343. 1926.

Pl. 18, fig. A.

Drejera puberula Torr. in U. S. & Mex. Bound. Surv. Bot. 123. 1859, in part.

Anisacanthus pumilus Wats. in Proc. Am. Acad. **18**: 133. 1883, in part, not Nees in DC. Prodr. **11**: 445. 1847.

Slender, vine-like shrub, 1.5–2.5 m. high; stems pubescent in lines; lower leaves lanceolate to ovate, 2.5–7 cm. long, 1–3 cm. broad, slightly acuminate, puberulent, pilose to tomentose, petioles 3–20 mm. long, tomentose; flowers borne in short racemose clusters in the axils of fallen leaves; bracts and bracteoles puberulent, sometimes glandular, obovate, elliptic or ovate, reduced from about 10 mm. to about 2 mm. in length; pedicels 3–8 mm. long, glandular; calyx 6–10 mm. long, stipitate-glandular, lobes separate almost to the base, linear-ligulate, somewhat attenuate; corolla mostly 5 cm. long, curved, slightly infundibuliform, lobes linear, recurved, longer than the tube; stamens alternate, inserted at the base of the central anterior lobe, anthers 4 mm. long, anther-sacs parallel, slightly oblique; disc at base of ovary about 1 mm. high; capsule 2 cm. long, stipe as long as or longer than the body; seeds 4, sometimes 1 or 2 aborted, about 5 mm. in diameter, slightly obliquely discoid, brown, more or less tuberculate.

DISTRIBUTION: central Mexican plateau region from Durango to Coahuila and Chihuahua.

MEXICO: CHIHUAHUA: gravelly banks along the Cibolo of the Rio Grande, May–June, *Bigelow s.n.* (NY); valley of the Rio Conchos below Santa Rosalia, April 21, 1847, *Gregg 504* (M, NY); vicinity of Chihuahua, alt. 1300 m., April 8–27, 1908, *Palmer 51* (F, M, NY); rocky hills near Chihuahua, March 23 & April 17, 1885, *Pringle 268* (F, M, NY); Bachimba Canyon, April 2, 1886, *Pringle 862* (C, F, M, NY); Santa Rosalia, south of Chihuahua, April 30, 1847, *Wislizenus 267* (M). COAHUILA: Valley of Parras, April 11, 1847, *Gregg 407* (M); Parras, June 8–28, 1880, *Palmer 1017* (F, NY), and Oct. 6–11, 1898, *430* (C, F, M, NY); Parras, Feb.–March, 1905, *Purpus 1046* (C, F, M, NY); Sierra de Parras, Oct., 1910, *Purpus 4752* (C, F, M). DURANGO: City of Durango and vicinity, April–Nov., 1896, *Palmer 25* (C, F, M, NY); Pueblita, April 11, 1900, *Trelease 75* (M).

3a. A. insignis Gray var. **linearis** Hagen, var. nov.[7]

Pl. 18, fig. B.

Lower leaves and those of the flowering branches sessile, linear to linear-lanceolate, 1–4 cm. long, 1–5 mm. broad, essentially glabrous.

DISTRIBUTION: southwestern Texas and northern Mexico.

TEXAS: CHISOS MOUNTAINS, BREWSTER CO.: lower end of Juniper Canyon, alt. 1158–1219 m., July 15–18, 1921, *Ferris & Duncan 2990* (M, NY); dry creek bed, lower Blue Creek Canyon, alt. 1370 m., June 23, 1931, *Moore & Steyermark 3202* (C, M TYPE, NY); Aug. 2, 1931, *Mueller 8166* (F, M); rocky cliffs and ledges, Oak Canyon, May 24, 1928, *Palmer 34148* (M, NY).

MEXICO: COAHUILA: near the northern entrance of El Puerto de San Lazaro, June 16, 1936, *Wynd & Mueller 106* (M).

4. A. Thurberi (Torr.) Gray, Syn. Fl. N. Am. **2**[1]: 328. 1878, and ed. 2, **2**[1]: 457. 1886; Hemsl. Biol. Centr.-Am. Bot. **2**: 522. 1882; Woot. & Standl. in Contr. U. S. Nat. Herb. **19**: 597. 1915; Standl. in Contr. U. S. Nat. Herb. **23**: 1342. 1926.

Drejera Thurberi Torr. in U. S. & Mex. Bound. Surv. Bot. 124. 1859.

Drejera puberula Torr. *Ibid.* 123.

Low shrub, 0.5–1.5 m. high; stem pubescence reduced to a few scattered hairs in two opposite lines; leaves lanceolate, mostly 3–5 cm. long, 7–15 mm. broad, hispid to glabrate, petioles 1–5 mm. long; flowers borne singly in the axils of the bract-like upper leaves, or in 2–5-flowered greatly foreshortened axillary racemose clusters; bracts and bracteoles lanceolate to linear, acute, mostly 2–10 mm. long, 1–3 mm. broad, puberulent, often slightly pilose along the midrib and margin; pedicels 3–7 mm. long, glandular; calyx .9–2 cm. long, deeply 5-cleft, stipitate-glandular, puberulent, with few pilose hairs scattered throughout, lobes linear-attenuate, more or less tentacular; corolla dull red, 3.5–4 cm. long, tube funnelform, lobes shorter than the tube, ovate, obtuse, divergent but scarcely recurved, upper lip slightly emarginate; stamens

[7] **Anisacanthus insignis** Gray var. **linearis**, var. nov., *A. insigni* similis, sed foliis inferioribus sessilibus linearibus vel lineari-lanceolatis, 1–4 cm. longis, 1–5 mm. latis, glabris differt.

epipetalous, inserted below the sinuses of the anterior lip, filaments about 2 cm. long, anther-sacs 3–4 mm. long, equal, parallel, connected to below the middle; capsule about 15–18 mm. long, about 6 mm. in diameter, stipe shorter than the subovoid body; seeds 2, slightly tuberculate, about 5 mm. in diameter.

DISTRIBUTION: from southern Sonora in Mexico northward along the western mountainous slopes into central Arizona, and eastward into the southwestern part of New Mexico.

UNITED STATES: ARIZONA: near creek, Rhoda Riggs' Ranch, Chiricahua Mts., alt. 1676 m., Oct. 22, 1906, *Blumer 1304* (F, M, NY); Box Canyon, Chiricahua Mts., alt. 1676 m., July 9, 1907, *Blumer 1248* (F, M, NY); Nogales, May, 1892, *Brandegee s.n.* (C); Fort Whipple, on gravelly hillsides, May 3, 1865, *Coues & Palmer 190-c* (M); 40 miles south of Fort Whipple, Aug. 5, 1865, *Coues & Palmer 130* (M); 5 miles west of Tucson, in Tucson Mts., March 7, 1934, *Detwiler 47* (F); Douglas, rocky draws and washes, May, 1907, *Goodding 2232* (C, M); dry, rocky hillsides 5 miles northeast of Rodeo, June 16, 1930, *Goodman & Hitchcock 1153* (C, F, M, NY); Rincon Pass, Oct. 19, 1900, *Griffiths 2018* (NY); Sabenio Cañon, March 30, 1901, *Griffiths 2595* (NY); Santa Ritas, foot of Old Baldy, April, 1901, *Griffiths 2652* (NY); Roadside Mine, Pima County, April 21, 1932, *Harrison & Kearney 8528* (F); hills along the Rio San Pedro, Sept. 9, 1858, *Hayes 598* (NY); Congress Junction, alt. 91 m., May 4, 1903, *Jones s.n.* (M); Cave Creek Canyon, Chiricahua Mts., 1829–2438 m., June 26–29, 1927, *Kusche s.n.* (F); Santa Catalina Mts., April, 1881, *Lemmon s.n.* (C); south of Bisbee, Mexican boundary line, Oct. 3, 1892, *Mearns 1024* (C, M, NY); Patagonia, May 6, 1902, *Orcutt s.n.* (C); 1869, *Palmer s.n.* (NY); Tucson, April, 1884, *Parish s.n.* (M), and May 25, 1884, *195* (F); Sierra Tucson, April 25, 1884, *Parish s.n.* (NY); Tucson, April, 1884, *Parish & Parish s.n.* (C); Picacho Mts., March 23, 1930, *Peebles 6473* (NY); Santa Catalina Mts., April 18, 1881, *Pringle s.n.* (F), and June, 1882, *s.n.* (M, NY); Sierra Tucson, April 25, 1884, *Pringle s.n.* (F), and June 1, 1884, *4832* (F, NY); Tucson, in arroyo, April 15, 1901, *Shear 4231* (NY); Tucson, date lacking, *Spring s.n.* (C); west of Sonoita, alt. 1433 m., April 18, 1934, *Stone 39* (NY); Stone Cabin Canyon, Santa Rita Mts., alt. 1524 m., May 23, 1903, *Thornber 294* (C, M); foothills of Tucson Mts., alt. 762 m., May 9, 1903, *Thornber 474* (C); Ft. Huachuca, May, 1892, *Wilcox s.n.* (NY), and 1894 (M).

NEW MEXICO: along the Gila River and mesa between cliff and upper canyon of Gila, Grant Co., alt. 1300–1350 m., July 25, 1920, *Eggleston 16794* (M); Mangas Canyon, May and June, 1880, *Greene s.n.* (NY), June 1, and July 3, 1880, *s.n.* (F), and June and July, 1880, *12502* (M); Dog Spring, Grant Co., May 26, 1892, *Mearns 113* (NY); Mangas Springs, 18 miles northwest of Silver City, alt. 1453 m., June 9, 1903, *Metcalfe 113* (C, M, NY); on the upper Rio Grande, below El Paso, 1851–1852, *Wright 1456* (M, NY).

MEXICO: SONORA: San Miguel de Horcasitas, May, 1892, *Eisen s.n.* (C); San Bernardo, Rio Mayo, Feb. 16, 1935, *Gentry 1309* (F, M, NY); El Alamo, Magdalena, May 25, 1925, *Kennedy 7107* (C); Torres, Jan.–March, 1902, *Purpus 409* (C, M).

5. A. quadrifidus (Vahl) Nees in Linnaea **16**: 307. 1842; Standl. in Contr. U. S. Nat. Herb. **23**: 1343. 1926.

Justicia coccinea Cav. Ic. Pl. **2**: 77, *pl. 199.* 1793, not Aublet.

Justicia quadrifida Vahl, Enum. Pl. **1**: 124. 1805.

Justicia virgularis Salisb. Parad. Lond. *pl. 50.* 1806.

(?) *Justicia superba* Hort. ex Nees in DC. Prodr. **11**: 445. 1847.

Anisacanthus virgularis (Salisb.) Nees in DC. Prodr. **11**: 445. 1847; Hemsl. Biol. Centr.-Am. Bot. **2**: 522. 1882; Gray, Syn. Fl. N. Am., ed. 2, **2**[1]: 457. 1886.

Younger branches green, somewhat purplish, pubescent in two opposite lines; leaves short-petiolate to subsessile, linear to lanceolate, long-acuminate, 2–5 cm. long, 3–13 mm. broad, glabrous except for minute pubescence at base and along midrib above, punctate, the upper leaves much reduced; inflorescence spicate, secund, flowers sessile to short-pedicillate, almost always solitary, rarely 2 in the axils of the upper bracts; bracts and bracteoles lanceolate, glandular, ciliate, 3–4 mm. long, caducous; calyx glandular, 6–10 mm. long, deeply 5-cleft, lobes ciliate, lance-acuminate, 5–6 mm. long at anthesis; corolla scarlet, 3.5–4 cm. long, slightly curved, scarcely dilated at the throat, lobes recurved, ligulate, about as long as the tube; stamens inserted at the sinuses of the anterior lip, anthers 3–4 mm. long, anther-sacs equal or nearly so, parallel; capsule 15–18 mm. long, stipe as long as the body; seeds 4, subdiscoid, about 5 mm. in diameter, more or less tuberculate.

DISTRIBUTION: central Oaxaca, Mexico, northward into Puebla, Hidalgo and Queretaro, and westward into San Luis Potosi and Zacatecas.

MEXICO: HIDALGO: Ixmiquilpan, July, 1905, *Rose, Painter & Rose 8944* (F, M, NY); OAXACA: Vallè de Oaxaca, alt. 1600 m., Nov. 8, 1906, *Conzatti 1519* (F); Las Naranjas, Aug., 1908, *Purpus 3018* (F, M, NY); Oaxaca Valley, alt. 1524 m., Nov. 7, 1894, *Smith 731* (M, NY); PUEBLA: vicinity of Puebla, Acatzinco, District of Tepeaca, alt. 2110 m., July, 1907, *Arsène & Amable 3567* (M, NY), and Aug., 1907, *1568* (M); Tehuacan, Dec., 1892, *Liebmann 10600* (F); Acatzinco, Nov., 1909, *Nicolas 35* (F); valley near Tehuacan, alt. 1524 m., Aug. 5, 1901, *Pringle 9390* (F, M); Tehuacan, Sept., 1911, *Purpus 5669* (C); near El Riego, Tehuacan, Sept., 1905, *Rose, Painter & Rose 10033* (F, M); QUERETARO: near San Juan del Rio, Aug. 17, 1905, *Rose, Painter & Rose 9515* (NY); same locality, Nov., 1827, *Berlandier 1237* (NY); SAN LUIS POTOSI: Dec. 27, 1848, *Gregg 578* (M); 1878, *Parry & Palmer 706* (F); gravel washes, Bocas, Aug. 17, 1891, *Pringle 3820* (C,

F, NY); region of San Luis Potosi, 1879, *Schaffner 367* (F, NY); ZACATECAS: city of Zacatecas, 1908, *Lloyd 10* (F).

Besides the above, several authentic collections from European gardens have been examined. Although data accompanying them are usually quite incomplete, they have been of importance in establishing the identity of this species.

6. A. Wrightii (Torr.) Gray, Syn. Fl. N. Am. **2**[1]: 238. 1878, and ed. 2, **2**[1]: 457. 1886; Hemsl. Biol. Centr.-Am. Bot. **2**: 522. 1882; Standl. in Contr. U. S. Nat. Herb. **23**: 1343. 1926.

Drejera Wrightii Torr. in U. S. & Mex. Bound. Surv. Bot. 123. 1859.

Drejera juncea Torr. *Ibid.* 124.

Anisacanthus junceus (Torr.) Hemsl. Biol. Centr.-Am. Bot. **2**: 522. 1882.

Young branches dull green, pubescent in two lines; lower leaves broadly lanceolate, 1–5 cm. long, 0.5–2 cm. broad, hispid to glabrate, petioles 3–10 mm. long, pilose; flowers usually borne singly or in pairs in secund, terminal, spicate inflorescences, subsessile to short-pedicellate; bracts and bracteoles lanceolate-acuminate, 2–5 mm. long, puberulent; calyx about 0.5 cm. long, puberulent, glandular, lobes ovate to lanceolate, 2–3 mm. long, acute, few, scattered hairs along margin and at tip; corolla 3–4 cm. long, lobes narrowly ovate, obtuse, posterior lobe slightly emarginate, tube slender, nearly straight, scarcely dilated at the throat, longer than the lobes; stamens epipetalous, inserted near the sinuses of the central anterior lobe, filament about 1 cm. long, anthers 3 mm. long, anther-sacs connected nearly half their length from the tips; ovary extending about 2 mm. above the disc; capsule about 15 mm. long, body about 6 mm. thick, shorter than the stipe; seeds 2, rarely 4, about 5 mm. in diameter.

DISTRIBUTION: mostly along the eastern part of the central plateau region of Mexico, in the states of Tamaulipas, Nuevo Leon, and Coahuila. It has been found at one station in northern Michoacan, and from several localities in Bexar, Uvalde, and Kinney counties in Texas.

UNITED STATES: TEXAS: Fort Clark, June–July, 1857, *Blake s.n.* (NY); San Antonio, Bexar Co., tropical life zone, June 27, 1911, *Clemens & Clemens s.n.* (F, M); Concan, Uvalde Co., along rocky creeks, June 15, 1916, *Palmer 10212*

(M); valley of the Rio Grande below Donana, *Parry, Bigelow, Wright & Schott s.n.* (NY); rocky banks along the Rio Frio, June, 1884, *Reverchon 1580* (F, M, NY); same locality, *Schott s.n.* (F), and Oct. 19, 1851, *733* (NY); Uvalde Co., growing along railroad, June 30, 1929, *Schultz 3057* (F); May–Oct., 1849, *Wright 435* (M, NY TYPE).

MEXICO: COAHUILA: La Pena, Nov., 1852, *Thurber 849* (NY TYPE of *Drejera juncea* Torr.); MICHOACAN: Morelia, Dos Tetecos, March 7, 1911, *Arsène 36* (F); NUEVO LEON: Monterrey, Guadalupe, alt. 540 m., June, 1911, *Arsène & Abbot 6228* (M); Monterrey, damp rich soil in thickets, *Edwards & Eaton s.n.* (NY); by streams, El Carrizo, alt. 427 m., June 16, 1906, *Lozano 10256* (C, F, M, NY); arroyos of mesas near Monterrey, July 23, 1888, *Pringle 1891* (C, F, NY); valley of Monterrey, June 17, 1889, *Pringle 2710* (C, F, M), and Aug. 19, 1903, *11663* (F); TAMAULIPAS: La Vegonia, vicinity of San Jose, alt. 823 m., July 20, 1930, *Bartlett 10526* (F); La Tamaulipeca, vicinity of San Miguel, July 27, 1930, *Bartlett 10670* (F); vicinity of Victoria, alt. 320 m., Feb. 1–April 9, 1907, *Palmer 120* (C, F, M, NY).

The specimens of Lozano and Bartlett are atypical, having calyces very nearly like those of *A. quadrifidus.* Thurber's specimen, which Torrey called *Drejera juncea,* is somewhat like the two above, but judging mainly by the glandular characters, general size of the calyx and of the anthers, its relationship is evidently with *A. Wrightii* rather than *A. quadrifidus.*

6a. A. Wrightii (Torr.) Gray var. **brevilobus** Hagen, var. nov.[8]

Lower leaves subsessile, lanceolate to linear-lanceolate, 1.5–4 cm. long, 3–8 mm. broad, glabrate; calyx 4–5 mm. long, the tube several times longer than the triangular, acute lobes.

DISTRIBUTION: northern Mexico, known only from the type locality.

MEXICO: COAHUILA: Chojo Grande, 27 miles southeast of Saltillo, July 16, 1905, *Palmer 719* (C, F, M TYPE, NY).

This variety is quite distinct on account of the short, triangular, acute calyx-lobes, and the narrower, subsessile leaves.

7. A. pumilus (Dietr.) Nees in DC. Prodr. **11**: 445. 1847; Gray, Syn. Fl. N. Am., ed. 2, **2**[1]: 457. 1886; Hemsl. Biol. Centr.-Am. Bot. **2**: 522. 1882; Standl. in Contr. U. S. Nat. Herb. **23**: 1342. 1926.

[8] **Anisacanthus Wrightii** (Torr.) Gray var. **brevilobus**, var. nov., foliis inferioribus subsessilibus lanceolatis vel lineari-lanceolatis, 1.5–4 cm. longis, 3–8 mm. latis, glabris; petiolis 1–2 mm. longis; calyce 4–5 mm. longo, lobis tubo brevioribus, triangularibus, acutis.

Justicia pumila Dietr. in Vollst. Lex. Gärtn. Nachtr. **4**: 197. 1818.

Drejera Greggii Torr. in U. S. & Mex. Bound. Surv. Bot. 124. 1859.

Anisacanthus Greggii (Torr.) Gray, Syn. Fl. N. Am. **2**[1]: 328. 1878.

Shrub, 2.5–3 m. high; stem dark brown, pubescent in two opposite decussating lines; leaves ovate-lanceolate to linear-lanceolate, 2–3 cm. long, 3–10 mm. broad, hispid, subsessile to short-petiolate; flowers in compact racemose clusters of from one to several borne in the axils of fallen leaves; bracts and bracteoles about 2 mm. long, puberulent, ciliate, acute; calyx short-pedicellate, about 7–12 mm. long, puberulent, pilose, deeply and subequally 5-lobed, the lobes about 6–9 mm. long, acute; corolla 4–5 cm. long, bright red, thinly pilose, slender, curved, slightly dilated at the throat, the linear-ligulate lobes longer than the tube, recurved; stamens inserted near the base of the central lobe of the anterior lip, anther-sacs 4 mm. long, nearly equal, parallel, connected about half way to the base; capsule about 2 cm. long, body 5–6 mm. thick, as long as the stipe; seeds 4, about 5 mm. in diameter, slightly tuberculate.

DISTRIBUTION: northern Michoacan to San Luis Potosi, and northwestward along the plateau region to southern Chihuahua.

MEXICO: Gonzales Junction, April, 1910, *Rusby s.n.* (NY); MICHOACAN: vicinity of Morelia, Quinceo, alt. 1900 m., March 11, May 25, 1909, *Arsène 2778* (M), and July 18, 1909, *s.n.* (NY); hills east of Zipimeo, May 11, 1849, *Gregg 810* (M); GUANAJUATO: Silao, July, 1903, *Purpus 140* (C); SAN LUIS POTOSI: in the region of San Luis Potosi, 22° N. Lat., alt. 1829–2434 m., 1878, *Parry & Palmer 706½* (M); CHIHUAHUA: battleground of Paso del Gallinero, near Dolores, Dec. 29, 1848, *Gregg 587* (NY TYPE of *Drejera Greggii* Torr., M).

8. **A. tulensis** Greenm. in Field Mus. Publ. Bot. Ser. **2**: 343. 1912.

Justicia superba Sessè & Moçiño, Pl. Nov. Hisp., ed. 2, p. 3. 1893, in part; not *J. superba* Hort. ex Nees in DC. Prodr. **11**: 445. 1847, in synonymy.

Ultimate branches tomentose to pilose over entire surface; leaves lanceolate to linear-lanceolate, 1.5–5 cm. long, 4–20 mm. broad, puberulent above, sparsely pubescent below, mostly

along the veins and margins, petioles 1–7 mm. long, tomentose to pilose; inflorescence mostly secund, racemose, usually not more than 2 flowers maturing in a cluster; bracts linear-lanceolate, 5–10 mm. long, puberulent, ciliate, bracteoles similar but smaller, both bracts and bracteoles caducous; pedicels 1–5 mm. long, tomentose to pilose, puberulent; calyx puberulent, tomentose to sparsely pilose, 10–14 mm. long, lobes lanceolate, as long as the tube or slightly longer; corolla 5–5.5 cm. long, finely pilose, tube slender, arcuate, about 2 cm. long, lobes linear-ligulate, recurved, distinctly longer than the tube, posterior lip slightly emarginate; stamens alternate, inserted near the base of the central lobe of the anterior lip, filaments 18–25 mm. long, anthers 4 mm. long, anther-sacs subequal, slightly oblique, connected almost half their length from the tip; capsule 17–25 mm. long, about 5–8 mm. thick, stipe longer than the body; seeds 4, subdiscoid, 5–6 mm. in diameter, tuberculate.

DISTRIBUTION: southern Mexico.

MEXICO: OAXACA: Santa Maria del Tule, alt. 1600 m., March 31, 1907, *Conzatti 1773* (F TYPE); MORELOS: Ayacapixtla, 1787–1795–1804, *Sessè & Moçiño 293* in part, and *373* (F).

EXCLUDED SPECIES

Anisacanthus glaberrimus Jones in Contr. West. Bot. No. 15: 151. 1929 = (?) **Odontonema.**

LIST OF EXSICCATAE

Arsène, G. *36* (6), —, *2778* (7).
Arsène, G. & Bro. Abbot. *6228* (6).
Arsène, G. & Bro. Amable. *1568, 3567* (5).
Bartlett, H. H. *10526, 10670* (6).
Berlandier, J. *1237* (5).
Bigelow, J. M. — (3).
Blake, S. F. — (6).
Blumer, J. C. *1248, 1304* (4).
Brandegee, T. S. — (1), — (4).
Clemens, Mr. & Mrs. Joseph. *1065* (6).
Conzatti, C. *1519* (5), *1773* (8).
Coues, Elliott & Edward Palmer. *130, 190-c* (4).
Detwiler, S. B. *47* (4).
Edwards, Dr., & Maj. Eaton. — (6).
Eggleston, W. W. *16794* (4).
Eisen, G. — (4).
Ferris, Roxana S. & C. D. Duncan. *2990* (3a).
Gentry, Howard Scott. *1178* (1), *1309* (4).
Goodding, Leslie N. *2232* (4).
Goodman, George J. & C. Leo Hitchcock. *1153* (4).
Greene, Edward Lee. —, —, *12502* (4).
Gregg, J. *407, 504* (3), *578* (5), *587, 810* (7).

Griffiths, David. *2018, 2595, 2652* (4).
Harrison, G. H. & T. H. Kearney. *8528* (4).
Hayes, Sutton. *598* (4).
Jones, Marcus E. — (4).
Kennedy, P. B. *7107* (4).
Kusche, J. Aug. — (4).
Lemmon, J. G. — (4).
Liebmann, F. M. *10600* (5).
Lloyd, Francis E. *10* (5).
Lozano, F. L. *10256* (6).
Mearns, Edgar A. *113, 1024* (4).
Metcalfe, O. B. *113* (4).
Moore, John Adam & Julian Steyermark. *3202* (3a).
Mueller, Cornelius H. *8166* (3a).
Nicolas, —, *35* (5).
Orcutt, C. R. — (4).
Palmer, Edward. *25, 51, 430, 1017* (3), — (4), *120* (6), *719* (6a).
Palmer, Ernest J. *10212* (6), *34148* (3a).
Parish, W. F. *195* (4).
Parish, Samuel B. & W. F. — (4).
Parry, C. C., J. M. Bigelow, Charles Wright & A. Schott. — (6).
Parry, C. C. & Edward Palmer. *706* (5), *706½* (7).
Peebles, R. H. *6473* (4).
Pringle, C. G. *268, 862* (3), —, —, —, *4832* (4), *1891, 2710, 11663* (6), *3820, 9390* (5).
Purpus, C. A. *140* (7). *409* (4), *1046, 4752* (3), *3018, 3041* (2), *3018, 5669* (5).
Reverchon, J. *1580* (6).
Rose, J. N., Joseph H. Painter & J. S. Rose. *8944, 9515, 10033* (5).
Rose, J. N., Paul C. Standley & P. G. Russell. — (1).
Rusby, H. H. — (7).
Schaffner, J. G. *367* (5).
Schott, A. —, *733* (6).
Schultz, Ellen D. *3057* (6).
Sessè, Moçiño, Castillo & Maldoñado. *293, 373* (8).
Shear, C. L. — (4).
Smith, Charles L. *731* (5).
Spring, —. — (4).
Stone, Mrs. Frederick M. *39* (4).
Thornber, J. J. *294, 474* (4).
Thurber, George. *849* (6).
Trelease, William. *75* (3).
Wilcox, T. E. —, — (4).
Wislizenus, F. *267* (3).
Wright, Charles. *1456* (4), *435* (6).
Wynd, F. Lyle & Cornelius H. Mueller. *106* (3a).

Index to Genera and Species

Previously published and accepted names are indicated by ordinary type; new names by **bold face** type; and synonyms by *italics.*

	Page
Anisacanthus	392
abditus	393
glaberrimus	402
Gonzalezii	394
Greggii	401
insignis	395
var. **linearis**	396
junceus	399
pumilus	400
pumilus	395
quadrifidus	393, 398
Thurberi	396
tulensis	401
virgularis	398
Wrightii	399
var. **brevilobus**	400
Beloperone	389
Carlowrightia	389
Chileranthemum	389
Drejera	386
Greggii	401
juncea	399
puberula	395, 396

	Page		Page
Thurberi	396	*pumila*	401
Wrightii	399	*quadrifida*	398
Jacobinia	389	*superba*	398, 401
Justicia	385	*virgularis*	398
coccinea	398	Odontonema	389, 402

EXPLANATION OF PLATE

PLATE 16

A. From Salisbury, 'Paradisus Londinensis,' *pl. 50.* 1806, illustrating *Justicia virgularis* Salisb., which equals *Anisacanthus quadrifidus* (Vahl) Nees.

B. From Cavanilles, 'Icones et Descriptiones Plantarum,' *pl. 199.* 1793, illustrating *Justicia coccinea* Cav., which equals *Anisacanthus quadrifidus* (Vahl) Nees, the type species of the genus.

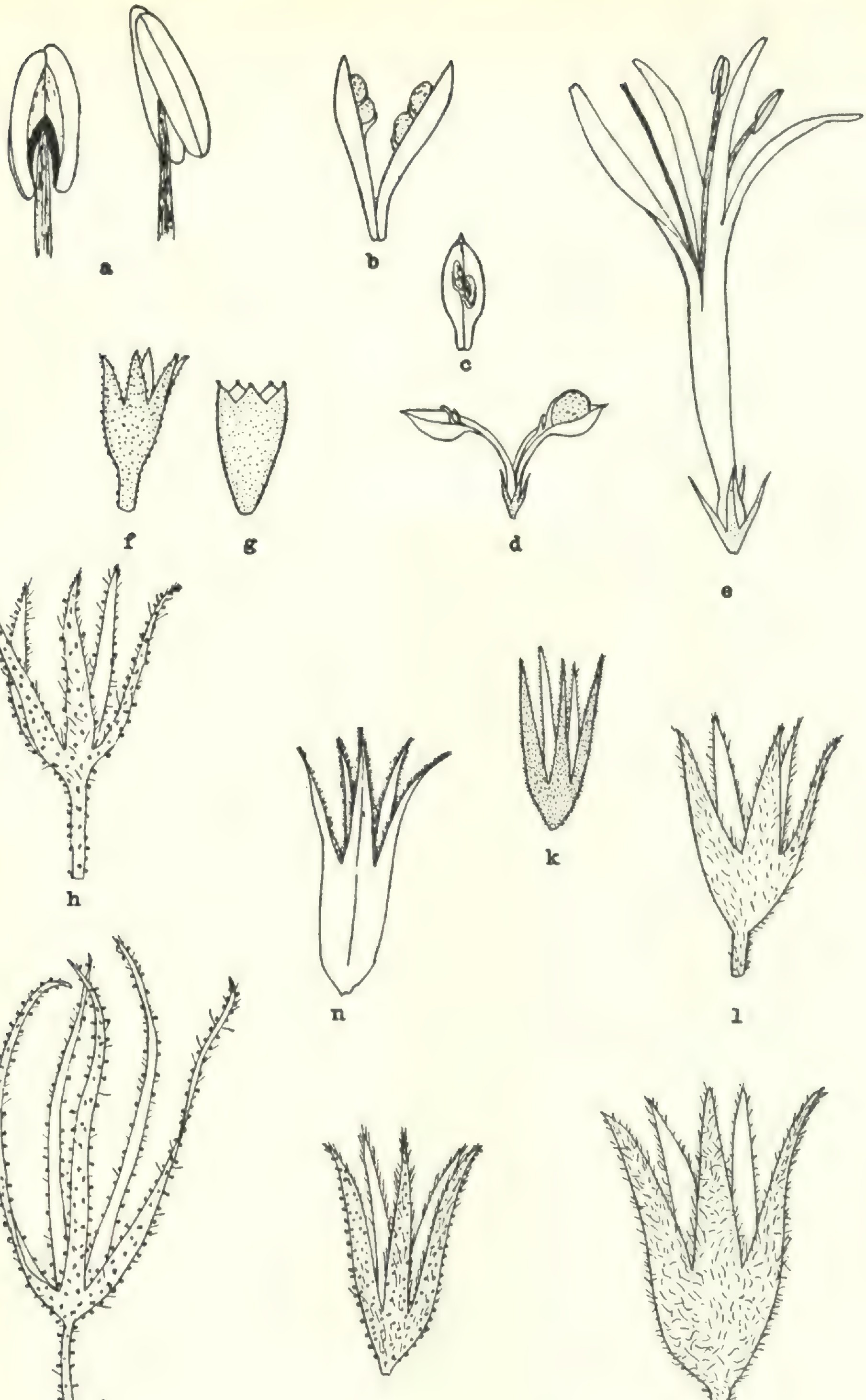
A

B

EXPLANATION OF PLATE

PLATE 17

a. Anther of *Anisacanthus quadrifidus* × 5.
b. Dehisced capsule of *Anisacanthus Gonzalezii* showing position of seeds, × 1.4.
c. Single valve of the capsule of *Anisacanthus abditus* inner-face view, × 1.4.
d. Dehisced capsule of *Anisacanthus quadrifidus* with one seed in place, × 1.4.
e. Single flower of *Anisacanthus quadrifidus*, × 2.1.
f. Calyx of *Anisacanthus Wrightii* × 3.5.
g. Calyx of *Anisacanthus Wrightii* var. *brevilobus* × 3.5.
h. Calyx of *Anisacanthus insignis* × 3.5.
i. Calyx of *Anisacanthus Thurberi* × 3.5.
j. Calyx of *Anisacanthus quadrifidus* × 3.5.
k. Calyx of *Anisacanthus abditus* × 3.5.
l. Calyx of *Anisacanthus pumilus* × 3.5.
m. Calyx of *Anisacanthus tulensis* × 3.5.
n. Calyx of *Anisacanthus Gonzalezii* × 3.5.


a
b
c
d
e
f
g
h
i
j
k
l
m
n

Explanation of Plate

PLATE 18

A. *Anisacanthus insignis* Gray. From a typical specimen, *Palmer 430*, in the Missouri Botanical Garden Herbarium.

B. *Anisacanthus insignis* Gray var. *linearis* Hagen. From the type collection, *Moore & Steyermark 3202*, in the Missouri Botanical Garden Herbarium.

No. 430
Anisacanthus insignis Gray
146469
HERBARIUM
430

A

1007516
PLANTS OF TEXAS

B

CONTRIBUTIONS TOWARD A FLORA OF PANAMA[1]

V. Collections chiefly by Paul H. Allen, and by Robert E. Woodson, Jr. and Robert W. Schery

ROBERT E. WOODSON, JR.
Assistant Curator of the Herbarium, Missouri Botanical Garden
Assistant Professor in the Henry Shaw School of Botany of Washington University

AND ROBERT W. SCHERY
Assistant in the Henry Shaw School of Botany of Washington University

LYCOPODIACEAE
(W. R. Maxon, Washington, D. C.)

Lycopodium Hoffmanni Maxon—chiriquí: Casita Alta to Cerro Copete, alt. 2300–3300 m., July 10, 1940, *Woodson & Schery 364*. New to Panama. Known previously only from Volcan Barba, Costa Rica, at 2500–2800 m.

Lycopodium orizabae Underw. & Lloyd—chiriquí: Casita Alta to Cerro Copete, alt. 2300–3300 m., July 10, 1940, *Woodson & Schery 365*. New to Panama. Heretofore known only from Orizaba, Mexico, and a single collection from Estrella, Costa Rica *(Stork 1959)*.

POLYPODIACEAE
(W. R. Maxon, Washington, D. C.)

Elaphoglossum revolutum (Liebm.) Moore—chiriquí: vicinity of Boquete, alt. 1200–1500 m., July 24–26, 1940. New to Panama. The specimens agree closely with type material collected in Mexico by Liebmann and with Cuban and Hispaniola specimens, of which a good series is at hand. *Elaphoglossum rampans* (Baker) Christ, founded on Wright's no. *3959*, from Cuba, is synonymous.

TAXACEAE
(P. C. Standley, Chicago)

Podocarpus **Allenii** Standl., sp. nov. Arbor excelsa 35 m. alta et ultra, trunco basi 1.5 m. diam., ramulis brevibus crassis sat

[1] Issued November 27, 1941.

dense foliatis; gemmae parvae vix ad 2 mm. longae, perulis crasse coriaceis apice rotundatis; folia alterna rigida coriacea anguste lanceolata, adulta 3.5–4.5 cm. longa 7–8 mm. lata, apicem rigidum fere spiniformem versus sensim attenuata, basi acuta et sessilia, costa supra prominente vel prominula, apicem versus minus prominente, subtus vix prominula saepius fere plana; caetera ignota.—PANAMÁ: moist upper region of Cerro Campana, alt. about 1000 m., April 21, 1941, *Allen 2437* (Herb. Field Mus., TYPE), *2424* (seedling); COCLÉ: hills north of El Valle de Antón, vicinity of La Mesa, alt. about 1000 m., Jan. 21, 1941, *Allen 2298*.

The collector's notes regarding the tree are as follows: "For nearly a year I have been picking up seedlings of this tree, anywhere from 45 cm. to 3.5 meters tall. They are everywhere in the hills above Campana, and north of El Valle, at elevations of 600 to perhaps 960 meters. Finally the mature trees have been located on Cerro Campana. The trees are about 33–36 meters tall, without branches for 18–21 meters. The huge columnar trunk is fully 1.5 meters in diameter, and covered with reddish brown, fissured bark somewhat resembling that of the California redwood."

It is with considerable diffidence that the writer proposes this new species of *Podocarpus,* although it seems to be quite as distinct as a good many other species that have been proposed in the genus. One might expect the Panama tree to be identical with *P. oleifolius* Don, common in the nearby mountains of Costa Rica, and extending southward to Peru. In Costa Rica the genus is confined, however, to the higher mountains, at 1400 to 3000 meters, and mostly at 2000 meters or more. *P. oleifolius* may be distinguished at once from *P. Allenii* by the fact that the costa is impressed rather than elevated on the upper leaf surface. So far as may be judged from leaf characters, *P. Allenii* is more closely related to *P. guatemalensis* Standl., of Guatemala and British Honduras, which also has the costa prominent upon the upper surface. *P. guatemalensis,* likewise, occurs at low elevations, descending to sea-level.

It is possible that ultimately *P. Allenii* will have to be combined with *P. guatemalensis*, but it is to be expected that flowers and fruit may furnish better characters for separating it. The adult leaves of the Panama tree are so much smaller than those of the northern one that it is believed by the writer that two distinct species are involved. The seedling leaves of *P. Allenii* are lance-linear, 9–12 cm. long, and 9–14 mm. wide. Mr. Allen states that the local name of this tree is *Cuahau*.

ERIOCAULACEAE

(H. N. Moldenke, New York)

Tonina fluviatilis Aubl.—chiriquí: vicinity of Boquete, alt. 1200–1500 m., July 24–26, 1940, *Woodson & Schery 752*. Known to occur from Cuba and British Honduras to Colombia, Trinidad and Brazil, but has not previously been collected in Panama.

BROMELIACEAE

(L. B. Smith, Cambridge, Mass.)

Aechmea **Allenii** L. B. Smith, spec. nov. (pl. 19), acaulis, stolonibus robustissimis procreans; foliis subfasciculatis, erectis, 6–7 dm. longis, inflorescentiam multo superantibus, utrinque lepidibus minutis peradpressis obtectis, vaginis magnis, anguste ellipticis, integris, quam laminis haud atrioribus, laminis ligulatis, late acutis et mucronatis, basi nullo modo angustatis, ad 55 mm. latis, dense serrulatis, viridibus, concoloribus; scapo gracili, ad 35 cm. alto, albido-flocculoso; scapi bracteis magnis, erectis, dense imbricatis, oblanceolatis, acutis, membranaceis, pulchre roseis, ad apicem versus denticulatis, basi flocculosis; inflorescentia erecta, simplicissima, densissime ellipsoidea, 8–10 cm. longa, 4 cm. diametro; bracteis florigeris erectis, inferioribus eis scapi similibus et flores multo superantibus, supremis anguste lanceolatis, acuminatis, integris, sepala aequantibus vel quam eis paulo brevioribus; floribus sessilibus; sepalis liberis, valde asymmetricis, mucro erecto ad 6 mm. longo incluso ad 23 mm. longis, cum ovario dense albido-lepidotis; petalis delapsis solum cognitis, ca. 3 cm. longis, basi ligulis binis dentatis auctis, albis vel pallide lilacinis [! Allen]; ovario orbiculato, valde compresso et triangulato, ad 17 mm.

longo, tubo epigyno crateriformi, placentis interno loculorum angulo prope apicem affixis, ovulis caudatis.—COCLÉ: epiphytic, vicinity of La Mesa, north of El Valle de Antón, alt. 1000 m., May 12, 1941, *P. H. Allen 2378* (U. S. Nat. Herb., TYPE; Gray Herb. and Herb. Missouri Bot. Garden, photograph); trail to Las Minas, north of El Valle de Antón, alt. 1000 m., May 10, 1941, *P. H. Allen 2467* (U. S. Nat. Herb.).

The very showy rose scape-bracts of *Aechmea Allenii* are suggestive of *Ae. Mariae-Reginae,* but the large long-mucronate sepals and the large serrulate lower floral bracts immediately set it apart from this and all related species.

AECHMEA TONDUZII Mez & Pittier—DARIEN: epiphytic, rain forest, Cana-Cuasi Trail, near Camp 2, Chepigana District, alt. 1650 m., March 12, 1940, *M. E. & R. A. Terry 1529* (Herb. Field Mus.); epiphytic, rain forest, Cana-Cuasi Trail near crest, Chepigana District, alt. 1500 m., March 15, 1940, *M. E. & R. A. Terry 1592* (Herb. Field Mus.). Previously known from Costa Rica; identified by description.

AECHMEA VEITCHII Baker—DARIEN: rain forest, north slope of Cana-Cuasi Trail, Real District, alt. 1650 m., March 13, 1940, *M. E. & R. A. Terry 1545* (Herb. Field Mus.). Previously known from Costa Rica and Colombia.

CATOPSIS WANGERINI Mez & Wercklé—CHIRIQUÍ: Finca Lérida to Peña Blanca, alt. 1750–2000 m., July 9, 1940, *Woodson & Schery 319.* Previously known from Costa Rica.

GUZMANIA DONNELLSMITHII Mez ex Donn. Smith—COCLÉ: epiphytic, vicinity of La Mesa, north of El Valle de Antón, alt. 1000 m., May 12, 1941, *P. H. Allen 2382* (U. S. Nat. Herb.). Previously known from Costa Rica.

GUZMANIA GLOMERATA Mez & Wercklé—COCLÉ: epiphytic, north rim of El Valle de Antón near Cerro Turega, alt. 650–700 m., June 30, 1940, *Woodson & Schery 199;* DARIEN: epiphytic, Cana-Cuasi Trail, Chepigana District, alt. 1200 m., March 12, 1940, *M. E. & R. A. Terry 1526* (Herb. Field Mus.); same (Camp 2), alt. 600 m., *M. E. & R. A. Terry 1528* (Herb. Field Mus.). Previously known from Costa Rica; identified by description.

GUZMANIA GUATEMALENSIS L. B. Smith—COCLÉ: epiphytic, vicinity of La Mesa, north of El Valle de Antón, alt. 1000 m., May 12, 1941, *P. H. Allen 2368* (U. S. Nat. Herb.); DARIEN: epiphytic, rain forest, Cana-Cuasi Trail near crest, Chepigana District, alt. 1500 m., March 15, 1940, *M. E. & R. A. Terry 1589* (Herb. Field Mus.). Previously known from Guatemala and Colombia.

GUZMANIA MUSAICA (Linden) Mez—DARIEN: epiphytic, rain forest, crest, Cana-Cuasi Trail, Real District, alt. 1650 m., March 16, 1940, *M. E. & R. A. Terry 1608* (Herb. Field Mus.). Previously known from Colombia.

PITCAIRNIA VALERII Standley—PANAMÁ: terrestrial, Cerro Campana, alt. 1000 m., April 21, 1941, *P. H. Allen 2414* (U. S. Nat. Herb.). Previously known from Costa Rica.

THECOPHYLLUM ACUMINATUM L. B. Smith—PANAMÁ: epiphytic, summit of Cerro Campana, alt. 800–1000 m., Sept. 1, 1940, *P. H. Allen 2215* (Herb. Field Mus.). Previously known from Costa Rica.

THECOPHYLLUM CRASSIFLORUM Mez & Wercklé—CHIRIQUÍ: terrestrial, Potrero Muleto to summit, Volcán de Chiriquí, alt. 3500–4000 m., July 13–15, 1940, *Woodson & Schery 453.* Previously known from Costa Rica.

THECOPHYLLUM ORORIENSE (Mez) Mez—CHIRIQUÍ: Finca Lérida to Peña Blanca, alt. 1750–2000 m., July 9, 1940, *Woodson & Schery 321.* Previously known from Costa Rica. Bracts green with orange tips instead of yellow and scarlet, but the plant otherwise close to the type.

TILLANDSIA ACOSTAE Mez & Tonduz—CHIRIQUÍ: epiphytic, vicinity of Puerto Armuelles, alt. 0–75 m., July 28–31, 1940, *Woodson & Schery 823.* Previously known from Costa Rica.

TILLANDSIA COMPLANATA Benth.—CHIRIQUÍ: epiphytic, vicinity of Bajo Mona and Quebrada Chiquero, alt. 1500 m., July 18, 1940, *Woodson & Schery 602.* Previously known from Costa Rica, the West Indies and northwestern South America.

TILLANDSIA INCURVA Griseb.—CHIRIQUÍ: epiphytic, vicinity of Finca Lérida, alt. 1750 m., July 7–11, 1940, *Woodson &*

Schery 223. Previously known from Costa Rica, southern Florida, Cuba, Jamaica, Venezuela, Colombia and Bolivia.

VRIESIA PACHYSPATHA Mez & Wercklé—CHIRIQUÍ: epiphytic, vicinity of Bajo Chorro, alt. 1900 m., July 20–22, 1940, *Woodson & Schery 679.* Previously known from Costa Rica; identified from description.

LILIACEAE

ANTHERICUM APODASTANTHUM Donn. Sm.—CHIRIQUÍ: Potrero Muleto, Volcan de Chiriquí, alt. 3500 m., July 13, 1940, *Woodson & Schery 379.* Previously known from Guatemala and Costa Rica.

ANTHERICUM MACROPHYLLUM Baker—COCLÉ: north rim of El Valle de Antón, near Cerro Turega, alt. 650–700 m., June 30, 1940, *Woodson, Allen & Schery 178.* Previously known from Costa Rica. This is probably the same plant recently described as *Anthericum panamense* Standl. (Field Mus. Publ. Bot. Ser. **22**: 327. 1940), based on a collection *(Allen 2195)* from the same locality. Our plants agree satisfactorily with Baker's original description.

AMARYLLIDACEAE

ZEPHYRANTHES CITRINA Baker—BOCAS DEL TORO: Isla Colon, alt. 0–120 m., Aug. 25, 1940, *H. von Wedel 543.* Previously known from Tropical America according to Baker, with no locality given. Type supposedly came from British Guiana. The species was described from a living specimen sent to England and cultivated there. It has since been introduced to Florida gardens.

ZEPHYRANTHES ROSEA Lindl.—BOCAS DEL TORO: Isla Colon, alt. 0–120 m., Aug. 25, 1940, *H. von Wedel 544.* Previously known from Cuba and described from a horticultural specimen brought to England. The species has since been introduced to Florida.

ZEPHYRANTHES TUBISPATHA Herb.—BOCAS DEL TORO: Isla Colon, alt. 0–120 m., Aug. 25, 1940, *H. von Wedel 542.* Previously known from Argentina? and Jamaica according to the Bot. Mag. A specimen, supposedly this species, from Tobago

is in the herbarium of the Missouri Botanical Garden. The species has been introduced into Florida where it is cultivated.

DIOSCOREACEAE

(C. V. Morton, Washington, D. C.)

Dioscorea Standleyi Morton—chiriquí: vicinity of Bajo Chorro, alt. 1900 m., July 21, 1940, *Woodson & Schery 664, 652.* Previously known from Costa Rica.

MARANTACEAE

Ctenanthe dasycarpa (Donn. Sm.) K. Sch.—bocas del toro: Isla Colon, Aug. 14, 1940, *H. von Wedel 433.* Previously known only from Costa Rica.

ORCHIDACEAE

(Lowis O. Williams, Cambridge, Mass.)

Palmorchis **trilobulata** L. O. Williams, sp. nov. (pl. 20). Herbae terrestres, caespitosae, usque ad 35 cm. altae. Folia subchartacea, plicata, elliptica, acuta vel acuminata. Inflorescentia terminalis, pauciflora; bracteae ellipticae vel lanceolato-ovatae, acutae vel acuminatae. Sepalum dorsale spathulato-oblanceolatum, obtusum, tri- vel quinquenervium. Sepala lateralia spathulato-oblanceolata, obtusa, arcuata, tri- vel quinquenervia. Petala lineari-oblanceolata, obtusa, leviter arcuata, trinervia. Labellum oblanceolato-flabellatum, tri-lobulatum; lobi laterales rotundati, obtusi; lobus medius transverse oblongus, lobos laterales paulo excedens. Columna generis.

Caespitose, terrestrial herbs up to 35 cm. tall. Stems up to about 15 cm. long and 4 mm. in diameter, bearing 3–4 leaves near the apex. Leaves subchartaceous, plicate; lamina of the mature leaves 10–22 cm. long and 3–6 cm. broad, elliptic, acute or acuminate, with 7 prominent nerves; petiole up to 7 cm. long, plicate, nervose. Inflorescence up to 7 cm. long, terminal, much exceeded by the leaves, few-flowered; rachis about 3–4 cm. long; bracts 1–1.5 cm. long and 1.5–5 mm. broad, elliptic to lanceolate-ovate, acute or acuminate. Flowers about 13 mm. long, white. Dorsal sepal about 12 mm. long and 3 mm. broad, spatulate-oblanceolate, obtuse, 3–5-nerved. Lateral sepals 10–

12 mm. long and 3–4 mm. broad, arcuate, spatulate-oblanceolate, obtuse, 3–5-nerved, somewhat carinate along the mid-nerve dorsally. Petals 11–12 mm. long and about 2 mm. broad, linear-oblanceolate, obtuse, somewhat arcuate, 3-nerved. Lip 10–12 mm. long and about 5–6 mm. broad near the apex, oblanceolate-flabellate, trilobulate at the apex, the base or claw adnate to the column along its median line for about 2–3 mm., more or less enfolding the column; disc of the lip pubescent, especially so toward the base and less so toward the apex, fleshy-thickened toward the apex; lateral lobes about 1 mm. long (free portion), rounded, obtuse; mid-lobe about 1.5 mm. long, transversely oblong, blunt, slightly exceeding the lateral lobes. Column slender, arcuate, about 10 mm. long; anther operculate, incumbent; pollinia 4, exappendiculate, ceraceous or appearing so, pyriform.—COCLÉ: terrestrial, flowers pure white; region north of El Valle de Antón, trail to Las Minas, alt. about 1000 m., May 10, 1941, *Allen 2463* (Herb. Ames, TYPE); terrestrial, flowers white; El Valle de Antón and vicinity, alt. 500–700 m., July 23–27, 1935, *Seibert 459* (Herb. Missouri Bot. Gard., Herb. Field Museum, Herb. Ames).

Palmorchis trilobulata is not easily confused with any previously described species of the genus. It is, perhaps, most closely allied to *P. Powellii* (Ames) Schweinf. & Correll, from which it is easily distinguished both vegetatively and by the size of the flowers, and especially by the very different lip.

PELEXIA FUNCKIANA (Rich. & Gal.) Schltr.—COCLÉ: terrestrial, flowers green; vicinity of La Mesa, hills north of El Valle de Antón, alt. about 1000 m., Jan. 21, 1941, *Allen 2315.* Previously known from Mexico, British Honduras, Guatemala and Costa Rica, possibly also in South America.

ACOSTAEA COSTARICENSIS Schltr.—COCLÉ: epiphytic, flowers tan; hills north of El Valle de Antón, alt. about 1000 m., Jan. 21, 1941, *Allen 2352.* The genus is new to Panama, previously known from Costa Rica.

PLEUROTHALLIS CONCAVIFLORA C. Schweinf.—COCLÉ: epiphytic; vicinity of El Valle de Antón, alt. about 600 m., Dec. 10, 1939, *Allen 2058;* epiphytic; vicinity of La Mesa, hills north of

El Valle de Antón, alt. about 1000 m., Jan. 21, 1941, *Allen 2317*. Previously known from Costa Rica.

Pleurothallis **macrantha** L. O. Williams, sp. nov. (pl. 21, figs. 1–6). Herbae caespitosae, epiphyticae vel terrestres, usque ad 23 cm. altae. Folia elliptica, obtusa, coriacea. Inflorescentia racema pluriflora quam folia duplo longior. Sepalum dorsale ellipticum vel oblanceolato-ellipticum, acutum. Sepala lateralia plusminusve usque ad apices connata, oblongo-oblanceolata, acuta. Petala oblongo-obovata, leviter obliqua, truncata vel paulo retusa. Labellum subteres et supra sulcatum, prope apicem expansum et basi biauriculatum et tricallosum. Columna generis.

Caespitose, epiphytic or terrestrial herbs up to 23 cm. tall. Secondary stems 6–8 cm. long, subequal to the leaves in length on mature plants, almost completely invested with 1 or 2 loose, scarious sheaths, unifoliate. Leaves 4–7 cm. long and 1.5–2.8 cm. broad, elliptic, obtuse, coriaceous. Inflorescence a several-flowered raceme, about twice exceeding the subtending leaves; sheath at the base of the peduncle short, about 9–11 mm. long; bracts 6–7 mm. long, ovate-lanceolate, scarious, semiamplexicaul. Dorsal sepal 16–20 mm. long and 6–8 mm. broad, elliptic to oblanceolate-elliptic, acute, 3-nerved, keeled dorsally along the mid-nerve. Lateral sepals 16–18 mm. long and together 6–8 mm. broad, connate almost to their apices, oblong-oblanceolate, acute, together 4-nerved, somewhat gibbous at the base. Petals about 9–11 mm. long and 5–6 mm. broad near the apex, oblong-obovate, slightly oblique, truncate or slightly retuse, 3-nerved, with an inconspicuous cushion-like callus near the base. Lip 10–12 mm. long and 3–4 mm. broad toward the apex when expanded, about 2 mm. broad near the middle and 3 mm. broad across the auriculate base, subterete and sulcate above, somewhat laterally compressed, expanding toward the apex and into 2 auricles at the base, with 3 small calluses between the basal auricles. Column of the genus.—CHIRIQUÍ: terrestrial, flowers pale greenish-yellow, spotted chocolate; vicinity of Bajo Chorro, alt. 1900 m., July 20–22, 1940, *Woodson & Schery 666* (Herb. Ames, TYPE).

Pleurothallis macrantha seems to be most closely allied to *P. pachyglossa* Lindl., with which it perhaps shares the distinction of having the largest flowers of the genus. *Pleurothallis macrantha* is distinguished from *P. pachyglossa* by the truncate petals, the laterally compressed lip, which differs in several characters, and by the details of the sepals and clinandrium.

PLEUROTHALLIS MURICATA Schltr. *(P. diuturna* Schltr.)—COCLÉ: epiphytic on Calabash tree; El Valle de Antón, alt. about 800 m., Jan. 20, 1941, *Allen 2294.* New to Panama under this name.

MALAXIS SIMILLIMA (Reichb. f.) O. Kuntze—CHIRIQUÍ: terrestrial; vicinity of Bajo Chorro, alt. 1900 m., July 20–22, 1940, *Woodson & Schery 685.* New to Panama, previously known from Costa Rica.

EPIDENDRUM (§ EUEPIDENDRUM) **Allenii** L. O. Williams, sp. nov. (pl. 22, figs. 3–5). Herbae epiphyticae, erectae, usque ad 3 dm. altae. Caules ancipiti. Folia elliptica vel lanceolata, acuta vel breviter acuminata. Sepalum dorsale lanceolatum, obtusum. Sepala lateralia sepalo dorsali similia sed leviter arcuata. Petala linearia, uninervia. Labellum unguiculatum; lamina subreniformis, subintegra vel obscure trilobata. Columna sectionis.

Erect epiphytic herbs up to about 3 dm. tall. Stems ancipitous, covered with the bases of the 3 to 6 leaves. Leaves 4–12 cm. long, 1.2–3 cm. broad, elliptic to lanceolate, acute or short-acuminate. Peduncle about 10–15 cm. long, ancipitous, bialate, the wings prominent at the base but disappearing at about the middle of the peduncle. Inflorescence short, the rachis covered with the scarious, imbricated bracts; bracts up to about 1 cm. long. Dorsal sepal about 10 mm. long and 4 mm. broad, lanceolate, obtuse, 5–7-nerved, with a short dorsal apicule near the apex. Lateral sepals similar to the dorsal sepal except somewhat arcuate. Petals about 10 mm. long and 0.75 mm. broad, linear, 1-nerved. Lip unguiculate; the lamina about 10 mm. long and 12 mm. broad, subreniform, subentire or obscurely 3-lobed, the terminal lobe inconspicuous and slightly

retuse, with two approximate submammillar calluses at the base. Column of the section, about 7 mm. long.—COCLÉ: epiphytic, leaves and stem red, sepals and petals pale pink, labellum white; hills north of El Valle de Antón, about 1000 m. alt., July 14, 1940, *Allen 2203* (Herb. Ames, 58635, TYPE).

Epidendrum Allenii seems not to be closely allied to any Central American species of *Epidendrum,* perhaps nearest to *E. panamense* Schltr. and to *E. Lankesteri* Ames (which may be synonyms), but differs from both of these by the very large differently shaped lip, by the wing on the peduncle and by other details.

EPIDENDRUM CRASSILABIUM Poepp. & Endl.—COCLÉ: *Allen 2205; Woodson & Schery 204.* A not uncommon species but apparently new to Panama. Previously known from Costa Rica, the West Indies, Brazil, Dutch Guiana, British Guiana, Venezuela, Colombia, Ecuador and Peru.

EPIDENDRUM DIFFORME Jacq. var. FIRMUM (Reichb. f.) AHS.—CHIRIQUÍ: epiphyte; Finca Lérida to Peña Blanca, alt. 1750–2000 m., July 9, 1940, *Woodson & Schery 298.* This variety has been reported previously from Guatemala and Costa Rica.

EPIDENDRUM (§ EUEPIDENDRUM) **ellipsophyllum** L. O. Williams, sp. now. (pl. 22, figs. 1–2). Herbae epiphyticae usque ad 25 cm. altae. Caules leviter fusiformes et indurati. Folia elliptica, breviter acuminata. Sepala elliptica vel oblanceolata, obtusa. Petala oblanceolata, obtusa. Labellum unguiculatum; unguis columnae adnata; lamina orbiculari-ovata, trilobata, lamellata, lobi laterales parvi. Columna sectionis.

Erect epiphytic herbs up to about 25 cm. tall. Stems slightly fusiform and indurated, with only the annual leaves persisting and the sheaths of the older leaves becoming scarious and disintegrating. Leaves 11–12 cm. long and 2–2.8 cm. broad, elliptic, short-acuminate, usually only 2 or 3 persisting. Peduncles up to about 4 cm. long, ancipitous, generally covered with imbricated bracts. Inflorescence short, 1-, or at most, few-flowered; bracts up to about 2 cm. long, cucullate, lanceolate-triangular, acute. Flowers green, segments stiff and coriaceous. Sepals 10–12 mm. long and 3–4 mm. broad, elliptic to

oblanceolate, obtuse, 5-nerved. Petals about 10–11 mm. long and 3–4 mm. broad, oblanceolate, obtuse, with 3 principal nerves. Lip unguiculate, the claw mostly adnate to the column; lamina 5–6 mm. long and 5–6 mm. broad, orbicular-ovate in outline, 3-lobed, the lateral lobes small and situated toward the base of the lip, with a 2-ridged lamellate callus plate at the junction of the claw and the lamina. Column slender, about 8 mm. long; clinandrium entire and obtuse; pollinia not seen.—COCLÉ: epiphytic, flowers green; hills north of El Valle de Antón, 1000 m. alt., June 23, 1940, *Allen 2178* (Herb. Ames, 58640, TYPE).

Epidendrum ellipsophyllum does not seem to be closely allied to any other Central American species but is perhaps nearest to *E. Lankesteri* Ames.

EPIDENDRUM (§ EUEPIDENDRUM) **gibbosum** L. O. Williams, sp. nov. (pl. 21, figs. 7–10). Herbae epiphyticae vel terrestres usque ad 4 dm. altae. Folia lineari-oblonga vel lineari-lanceolata, obtusa, coriacea. Inflorescentia brevis, racemosa, pauciflora. Sepalum dorsale elliptico-oblongum, obtusum. Sepala lateralia oblongo-ovata, obtusa. Petala elliptica vel oblongo-oblanceolata, obtusa. Labellum late oblongum vel suborbiculare, obtusum et leviter emarginatum, basi cordatum, carnosum, leviter gibbosum. Columna sectionis.

Epiphytic or terrestrial herbs up to 4 dm. tall. Stems simple or branched below, covered with the ample leaf-sheaths. Leaves 9–14 cm. long and 15–18 mm. broad, linear-oblong to linear-lanceolate, obtuse and unequally bilobed, articulate, coriaceous. Leaf-sheaths ample, somewhat inflated, disintegrating with age. Inflorescence short, racemose, few-flowered; bracts 10–18 mm. long and 12–22 mm. broad, cochleate, acute, scarious. Dorsal sepal 10–12 mm. long and 5–6 mm. broad, elliptic-oblong, obtuse, apiculate, 5–7-nerved. Lateral sepals 10–12 mm. long and 6–7 mm. broad, oblong-ovate, obtuse, apiculate dorsally, 7-nerved. Petals about 10 mm. long and 5 mm. broad, elliptic to oblong-oblanceolate, obtuse, 5–7-nerved. Lip about 11–12 mm. long and 9–10 mm. broad, broadly oblong or suborbicular, obtuse or shallowly emarginate, cordate at the

base, fleshy, especially tumid along the median nerve toward the apex, with 2 inconspicuous calluses at the base, basal portion somewhat gibbous and partly enfolding the column. Column of the section, about 4 mm. long.—CHIRIQUÍ: terrestrial, flowers maroon; Casita Alta to Cerro Copete, alt. 2300–3300 m., July 10, 1940, *Woodson & Schery 367* (Herb. Missouri Bot. Gard., TYPE).

Epidendrum gibbosum is most closely allied to *E. barbae* Reichb. f., a species native of Costa Rica, from which it may be distinguished by the shape and base of the lip and the different callus thickenings. The leaves of *E. gibbosum* are quite obtuse and unequally bilobed, while those of *E. barbae* are more or less acute and not unequally bilobed. The column of *E. gibbosum* is situated well down within the gibbous base of the lip while that of *E. barbae* is not. Although the specimen of this species was terrestrial, it is a potential epiphyte.

EPIDENDRUM (§ EUEPIDENDRUM) **pendens** L. O. Williams, sp. nov. (pl. 23). Herbae epiphyticae, pendentes, usque ad 45 cm. longae. Folia elliptica vel elliptico-lanceolata, coriacea, disticha, marginata. Inflorescentia uni–pauciflora. Sepalum dorsale oblongo-oblanceolatum, acutum, carnosum. Sepala lateralia elliptica, acuta, carnosa. Petala linearia, obtusa vel acuta, carnosa. Lamina labelli trilobulata, suborbicularis, nervo medio crassato et nervis radiantibus crassatis ornata; lobi laterales rotundati; lobus medius subquadratus, emarginatus. Columna generis.

Pendent, epiphytic herbs about 45 cm. long. Leaves 9–15 cm. long and 2–3.5 cm. broad, elliptic to elliptic-lanceolate, coriaceous, distichous, marginate, gray, deciduous; leaf-sheaths loose, completely investing the stem, pergameneous, ancipitous, the abscission line prominent. Inflorescence of 1 or few large, terminal flowers subtended by a leaf-like sheath up to 3 cm. long. Flowers large for the genus, green. Dorsal sepal about 5 cm. long and 1.2 cm. broad, oblong-oblanceolate, acute, fleshy, with 5–7 main nerves. Lateral sepals 4.3–4.8 cm. long and 1.5 cm. broad, elliptic, acute, fleshy, with about 7 main nerves. Petals about 4.5–5 cm. long and 2 mm. broad,

linear, somewhat narrowed to the base, obtuse or acute, fleshy, 1-nerved. Lip with the claw adnate with the column to the apex of the column; lamina about 2.5–3 cm. long and 3 cm. broad, 3-lobed, suborbicular in general outline, with a thickened central nerve and with thickened nerves or ridges radiating from it and covering the remainder of the lip, lateral lobes rounded, about 1.5 cm. long, mid-lobe 1–1.5 cm. long and about 1.5 cm. broad, subquadrate, emarginate. Column 1.5–2 cm. long and 6–8 mm. in diameter at the apex, fleshy.—COCLÉ: epiphytic, pendent plants, foliage gray, flower terminal, green; vicinity of La Mesa, El Valle de Antón, alt. about 1000 m., June 22, 1941, *Allen 2570* (Herb. Ames, TYPE).

Epidendrum pendens is most closely allied to *E. Medusae* (Reichb. f.) Pfitz., a rare plant of the Ecuadorian Andes, from which it is easily distinguished by the 3-lobed, nonfimbriated lip. If the genus *Nanodes* Lindl. were maintained this species would be the third one known.

Mr. Allen's note (in lit.) is of considerable interest: "Epiphytic, entire plant directly pendent, foliage distichous, stiff, gray, flowers terminal, green. This is one of the most remarkable orchids I have ever seen. The foliage is a dead, almost lead-gray, although the plant was the picture of perfect health. The flower is the sort of thing that you would expect a child to construct, after being told in a general way what the floral pattern of an orchid should be."

The description is from a dried plant and a single flower preserved in spirits.

EPIDENDRUM RAMOSUM Jacq. var. **angustifolium** (Cogn.) L. O. Williams, comb. nov. (*E. imbricatum* Lindl. var. *angustifolium* Cogn. in Mart. Fl. Bras. **3**[5]: 171. 1898, as var. *angustifolia; E. imbricatum* Lindl. Gen. & Sp. Orch. Pl. 110. 1831, non Lam.; *E. ramosum* Jacq. var. *imbricatum* (Lindl.) Ames, Hubbard & Schweinf. in Bot. Mus. Leafl. Harv. Univ. **2**: 47. 1934). —BOCAS DEL TORO: epiphytic, Río Cricamola, between Finca St. Louis and Konkintoë, alt. 10–15 m., Aug. 12–16, 1938, *Woodson, Allen & Seibert 1898*. Cogniaux' varietal name is correct

for this unit when it is maintained as a variety. The specimen cited above is the only one from Panama.

SCAPHYGLOTTIS **Lindeniana** (Rich. & Gal.) L. O. Williams, comb. nov. (*Hexadesmia fasciculata* Brongn. in Ann. Sci. Nat. Bot. II, **17**: 44. 1842, non *Scaphyglottis fasciculata* Hook.; *H. Lindeniana* Rich. & Gal. in Ann. Sci. Nat. Bot. III, **3**: 23. 1845; *H. rhodoglossa* Reichb. f. in Bonplandia **4**: 326. 1856; *H. pachybulbon* Schltr. in Fedde Repert. Beih. **17**: 26. 1922; *H. falcata* C. Schweinf. in Bot. Mus. Leafl. Harv. Univ. **8**: 45, *pl.* 1940).—COCLÉ: epiphyte, flowers light green; hills north of El Valle de Antón, alt. 800–1000 m., Jan. 2, 1941, *Allen 2291*. An extremely variable species as to flower size, the present specimen having very small flowers. Previously known from Mexico to Panama.

SCAPHYGLOTTIS (§ HEXADESMIA) **tenella** L. O. Williams, sp. nov. (pl. 24). Herbae epiphyticae, tenellae, caespitosae, usque ad 5 dm. altae. Caules elongati, tenelli, sub apicibus fusiformes. Folia linearia vel lineari-lanceolata. Sepala lanceolata, acuta. Petala oblongo-lanceolata, acuta vel obtusa. Labellum rhombico-lanceolatum. Columna sectionis.

Slender, caespitose, epiphytic herbs up to about 5 dm. tall. Stems elongated, slender, becoming naked and in age swollen and fusiform below the summit, bifoliate. Leaves 20–23 cm. long and 7–16 mm. broad, linear to linear-lanceolate, acute or the apex minutely bilobulate. Inflorescence terminal in the axis of leaves, a fascicle of 1 or few flowers. Dorsal sepal 8–9 mm. long and 3–3.5 mm. broad, lanceolate, acute, 5-nerved. Lateral sepals 8–9 mm. long and 3–4 mm. broad, lanceolate, acute, 5–7-nerved. Petals 8–9 mm. long, 3–3.5 mm. broad, oblong-lanceolate, acute or obtuse, 3- or 5-nerved. Lip about 8–9 mm. long and 4–5 mm. broad, rhombic-lanceolate but somewhat constricted above the middle, fleshy. Column of the section, about 5 mm. long; pollinia 6, waxy.—COCLÉ: epiphytic; hills north of El Valle de Antón, alt. 800–1000 m., Nov. 21, 1940, *Allen 2276* (Herb. Ames, TYPE).

Scaphyglottis tenella is allied to *S. pulchella* (Schltr.) L.

Wms.[1] but is easily distinguished by the smaller flowers and differently shaped lip.

ZYGOPETALUM **parviflorum** L. O. Williams, sp. nov. (pl. 25). Herbae robustae, terrestres vel epiphyticae, usque ad 1 m. altae. Folia lineari-elliptica vel elliptica, acuta vel acuminata, plicata. Scapus bracteosus; inflorescentia racemosa, pluri-multi-flora; bracteae lineares vel lineari-lanceolatae, acutae. Sepalum dorsale oblongo-ovatum, acutum, carnosum. Sepala lateralia oblongo-ovata, obtusa, carnosa. Petala oblonga, obtusa, leviter obliqua. Labellum oblongum, panduratum, apice rotundatum, prope basim callo lunato ornatum. Columna generis.

Robust, terrestrial or epiphytic herbs up to 1 m. tall. Stems leafy, short, becoming thickened into pseudobulbs, up to 9 cm. long and 1.5 cm. thick. Leaves 30–70 cm. long and 2.5–7 cm. broad, linear-elliptic to elliptic, acute or acuminate, plicate, attenuated at the base into a petiole. Scape up to 1 m. long, with several bracts; inflorescence racemose, several–many-flowered, bracts 5–14 mm. long, linear to linear-lanceolate, acute. Dorsal sepal about 10 mm. long and 5 mm. broad, oblong-ovate, acute, fleshy. Lateral sepals 10–11 mm. long and 5–6 mm. broad, oblong-ovate, obtuse, 5-(7-)nerved, fleshy. Petals about 7–8 mm. long and 4–4.5 mm. broad, oblong, obtuse, slightly oblique, 5-nerved. Lip 7–8 mm. long and 6.5–7.5 mm. broad, oblong, panduriate, about 2 mm. broader above the middle than below the middle, the apex broadly rounded, with a transverse, lunate callus at the base, fleshy. Column of the genus.—CHIRIQUÍ: terrestrial, flowers purple, lip violet, column white; vicinity of Bajo Chorro, alt. 1900 m., July 20–22, 1940, *Woodson & Schery 605* (Herb. Ames, TYPE); in rain forest, Bajo Chorro, Boquete District, alt. 6000 ft., Feb. 28, 1938, *Davidson 345*.

Zygopetalum parviflorum is not closely allied to any other species of the genus which is known to me. The flowers are much the smallest of the racemose species of the genus. The

[1] SCAPHYGLOTTIS **pulchella** (Schltr.) L. O. Williams, comb nov. *(Ramonia pulchella* Schltr. in Fedde Repert. Beih. **19**: 295. 1923).

present species resembles a *Euzygopetalum* in all respects except the small size of the flowers.

MAXILLARIA **Biolleyi** (Schltr.) L. O. Williams, comb. nov. (*Ornithidium Biolleyi* Schltr. in Fedde's Repert. **9**: 29. 1910).—CHIRIQUÍ: epiphyte in rain forest; Bajo Chorro, Boquete District, alt. about 2000 m., Jan. 14, 1938, *Davidson 125*. Known in Costa Rica and Panama.

MAXILLARIA **Bradeorum** (Schltr.) L. O. Williams, comb. nov. (*Camaridium Bradeorum* Schltr. in Fedde's Repert. Beih. **19**: 141. 1923).—CHIRIQUÍ: epiphyte in rain forest; Bajo Chorro, Boquete District, alt. about 2000 m., Jan. 13, 1938, *Davidson 118*. Known in Costa Rica and Panama.

MAXILLARIA **fulgens** (Reichb. f.) L. O. Williams, comb. nov. (*Ornithidium fulgens* Reichb. f. Beitr. Orch. Cent. Am., p. 76. 1866).—COCLÉ: epiphytic; hills north of El Valle de Antón, alt. 800–1000 m., Nov. 21, 1940, *Allen 2256*. Previously recorded from Costa Rica.

MAXILLARIA **umbratilis** L. O. Williams, nom. nov. (*Camaridium nutantiflorum* Schltr. in Beih. Bot. Centralbl. **36**, Abt. 2: 417. 1918, non *Maxillaria nutantiflora* Schltr.).—CHIRIQUÍ: epiphyte in rain forest; Bajo Chorro, Boquete District, alt. about 2000 m., Feb. 18, 1938, *Davidson 308*. Known in Costa Rica and Panama.

ONCIDIUM PANDURIFORME Ames & Schweinf.—CHIRIQUÍ: epiphyte; vicinity of Bajo Chorro, alt. 1900 m., July 20–22, 1940, *Woodson & Schery 704*. Previously recorded from Costa Rica.

LEOCHILUS GRACILIS Schltr.—COCLÉ: epiphytic, growing on Calabash, sepals and petals yellow, striped reddish-brown, lip yellow with spot of red at base, pseudobulbs and leaves dark bronzy red; El Valle de Antón, alt. about 800 m., Jan. 20, 1941, *Allen 2295*. Previously recorded from Honduras and Costa Rica.

CAMPYLOCENTRUM BRENESII Schltr.—CHIRIQUÍ: epiphyte; vicinity of Bajo Mona and Quebrada Chiquero, alt. 1500 m., July 18, 1940, *Woodson & Schery 579*. New to Panama, previously known from Costa Rica.

PIPERACEAE

(William Trelease, Urbana, Ill.)

PEPEROMIA **Scheryi** Trel., spec. nov. Herba terrestris sat magna glabra; caulibus inferne crassiusculis superne gracilibus; foliis alternatis peltatis rotundato-ovatis breviter acuteque acuminatis basi aliquantulum concavis ca. 13 cm. longis 8.5 cm. latis, petiolis gracilibus 5–7 cm. longis; spicis solitariis terminalibus ca. 100 mm. longis 5 mm. crassis, pedunculo gracili ca. 2 cm. longo ad apicem in ramulo 2-bracteato ca. 3 cm. longo gesto; baccis elongato-ovoideis rostratis, stigmate ad basim in rostro anteriori gesto.—CHIRIQUÍ: Quebrada Velo, vicinity of Finca Lérida, alt. ca. 1800 m., July 8, 1940, *Woodson & Schery 247* (Herb. Univ. Illinois, TYPE).

PIPER **fagopyricarpum** Trel., spec. nov. Frutex parvus glaber; internodiis elongatis gracillimis; foliis lanceolato-ellipticis apice acute caudatis basi acutis ca. 12 cm. longis 4 cm. latis omnino pinnate nervatis, nervis utraque latere ca. 10, post exsiccationem firme chartaceis, petiolis 0.5 cm. longis; spicis ca. 40 mm. longis 5 mm. crassis, pedunculo gracili 10 mm. longo; baccis sulcate ovoideis apiculatis, stigmatibus parvis.—CHIRIQUÍ: vicinity of Puerto Armuelles, alt. 0–75 m., July 28–31, 1940, *Woodson & Schery 852* (Herb. Univ. Illinois, TYPE).

LORANTHACEAE

PSITTACANTHUS **Scheryi** Woodson, spec. nov. *(Eupsittacanthus Ligulati).* Frutex parasiticus omnino glaber; ramis ramulisque crassis teretibus ad nodos haud incrassatis continuis. Folia opposita vel subopposita breviter petiolata inaequilateraliter rhombo-ovata apice late obtusa vel subrotundata basi latissime cuneata petiolo brevissimo incluso 9–11 cm. longa 6.0–9.5 cm. lata valde coriacea olivacea nervo medio immerso nervis lateralibus penninerviis et vix sensis. Inflorescentiae laterales fasciculatae congestae; pedunculis foliorum petiolos subaequantibus; pedicellis ca. 0.5 cm. longis. Flores gemini inferne aurantiaci superne lutei; cupula prorae simili submembranacea margine integro ca. 0.2 cm. longa 0.1 cm. lata; calyculo urceolato ca. 0.25 cm. alto ostio 0.2 cm. diam. obconico

margine integro; perigonio gracili maturitate 3.2 cm. longo prope basim conspicue (ca. 0.2 cm. diam.) dilatato; lobis 6 basi inconspicue incrassato-appendiculatis; antheris basifixis late oblongis 0.2 cm. longis, filamentis invicem inaequilongis 2.0–2.3 cm. longis paulo supra medium perigonii adnatis; stigmate late fusiformi, stylo perigonium subaequante.—CHIRIQUÍ: vicinity of Bajo Mona and Quebrada Chiquero, alt. 1500 m., July 18, 1940, *Woodson & Schery 581* (Herb. Missouri Bot. Garden, TYPE).

This striking species is closely related to *Ps. dilatatus* A. C. Smith, of Colombia, but has much broader leaves and a smaller calyculus with entire margin. The plant from which the type specimen was obtained was a magnificent epiphytic shrub of many stout branches, several of which were nearly 6 feet in height.

BALANOPHORACEAE

CORYNAEA CRASSA Hook f.—CHIRIQUÍ: thick bamboo thicket, below Potrero Muleto, Volcan de Chiriquí, alt. ca. 3500 m., July 13–15, 1940, *Woodson & Schery 470*. Previously known from Costa Rica and Colombia. Apparently parasitic on the roots of bamboo. The tuberous rhizomes attain a diameter of nearly a foot.

ANNONACEAE

CYMBOPETALUM **lanugipetalum** Schery, spec. nov. Arbor; ramis novellis brunneo-pubescentibus, internodiis ca. 2 cm. longis; foliis elliptico-lanceolatis subsessilibus, petiolis ca. 0.1–0.2 cm. longis, laminis coriaceis utrinque glabris apice angustis cuspidatisque basi fere obtusis inaequilateraliterque subrotundis 15–27 cm. longis 5–7 cm. latis nervis subtus prominentibus secundariis sat distantibus inter se laxe reticulatis prope marginem late arcuatim confluentibus deinde usque marginem reticulatis. Flores solitarii subterminales; pedicello pendulo ca. 20 cm. longo; sepalis minutis ca. 0.3 cm. longis; petalis interioribus carnosis cucullatis minute velutinis sessilibus triangulari-ovatis ca. 3 cm. longis 1.5 cm. latis venis

profunde immersis; petalis exterioribus coriaceis subtriangularibus sparse puberulis 1.8–2.0 cm. longis 1.0–1.6 cm. latis; staminibus multis capitatis ca. 0.5 cm. longis.—COCLÉ: north rim El Valle de Antón near Cerro Turega, alt. 650–700 m., June 30, 1940, *Woodson & Schery 191a* (Herb. Missouri Bot. Gard., TYPE).

This species is characterized by its moderately long pendulous pedicels, glabrous leaves, large fleshy velvety-pubescent inner petals, and very small calyx lobes. The leaves are elliptic-lanceolate with very prominent mid-veins and prominent confluent lateral veins which unite near the leaf margin, giving a lobed appearance to the reticulum. The outer petals are not fleshy and are only slightly more than half as large as the inner ones. The flowers are green.

DESMOPSIS **glabrata** Schery, spec. nov. Arbuscula circ. 3 m. alta; ramulis gracilibus novellis lentissimis pubescentibus vel glabratis, cortice rufo-bruneo, internodiis 3–6 cm. longis; foliorum laminis subcoriaceis, utrinque glabratis, ellipticis, basi cuneatis ibique in petiolum decurrentibus, apice gradatim acuminatis, acumine 5–15 mm. longo, 10–20 cm. longis, 3–6.5 cm. latis, costa supra leviter impresso, subtus valde prominente, nervis lateralibus utrinque 6–8 arcuatim adscendentibus, circ. 5 mm. infra marginem conjunctis; petiolis glabratis asperis, supra canaliculatis, circ. 5 mm. longis; inflorescentiis foliis oppositis vel subopppositis, 1-floris (in typo); pedunculis circiter 1 cm. longis, prope apicem bracteam rotundo-cordatam foliaceam gerentibus, circ. 2 cm. longis; florum pedicellis circ. 6–8 cm. longis, gracillimis, leviter pubescentibus, ad medium quorum est bractea squamiformis circ. 1 mm. longa; sepalis 3, ovato-triangularibus, 3 mm. longis latisque, crassis, extus pubescentibus, intus lepidote glabratis; petalis 6, linearibus vel lineari-lanceolatis, 13 mm. longis, basi 3–4 mm. latis, apice inflexis et obtuse acuminatis, crassis, valvatis, extus pubescentibus, intus lepidote glabratis, basi marginibus vulgo revolutis, staminibus subpeltatis, 1–1.2 cm. longis; ovariis pilosissimis, 7-carpellatis; stylis brevibus; stigmatibus subclavato-capitatis, setaceo-pubescentibus, 2 mm. latis; fructibus ignotis.—BOCAS

DEL TORO: vicinity of Bocas del Toro, alt. near sea-level, Aug. 1, 1940, *H. Wedel 279* (Herb. Missouri Bot. Gard., TYPE).

This species is evidently closely related to *D. microcarpa* R. W. Fries, from which it can be distinguished by the gradually acuminate apex of the leaves, the larger foliaceous bracts, the longer pedicels, and the narrow bluntly acuminate petals, densely pubescent without. The leaves are almost perfectly elliptic, entirely glabrous on both surfaces. The short peduncle bears a large foliaceous bract, from which extends the slender pedicel. Midway up the pedicel is found a small squamiferous bract. The flowers are thick and leathery, densely pubescent without and lepidote-glabrous within. The ovary, style and stigma are densely hairy. The torus is cylindric, truncate.

CUNONIACEAE

WEINMANNIA **pseudolaurina** Woodson, spec. nov. Arbor ut dicitur ca. 8 m. alta; ramulis juventate conspicue compressis minute sparseque pilosulis tandem teretibus glabris. Folia simplicia breviter petiolata late elliptica apice obtusa vel late acuta basi obtusa margine levissime crenata petiolo ca. 0.2–0.4 cm. longo incluso 5–10 cm. longa coriacea nitida subtus nervo medio rare inconspicue pilosulo caeterumque glaberrima. Inflorescentiae fasciculatae ca. 8 cm. longae, axibus minute puberulis. Flores in fasciculis inter se 0.2–0.5 cm. distantibus aggregati; pedicellis 0.2–0.3 cm. longis puberulis. Sepala 5 ovato-lanceolata acuminata ca. 0.1 cm. longa apice minute barbata. Petala ignota. Stamina 10; filamentis anguste subuliformibus ca. 0.2 cm. longis glabris. Ovarium ovoideum ca. 0.1 cm. longum pilosum. Folliculi ca. 0.3 cm. longi dense pilosuli; seminibus late oblongoideis rufis ca. 0.1 cm. longis pilosis.—PANAMÁ: Cerro Campana, trail from Campana to Chica, alt. 600–800 m., Aug. 10, 1941, very common along edges of grassland, *P. H. Allen 2656* (Herb. Missouri Bot. Gard., TYPE).

Weinmannia laurina H.B.K., to which our species is closely related, bears glabrous ovaries and follicles, more lax, elongate inflorescences, and more sharply crenate-serrulate leaves.

CONNARACEAE
(J. A. Steyermark, Chicago)

CONNARUS **Allenii** Steyermark, sp. nov. Folia 3–5-foliolata, foliolis oblanceolatis subito breviter acuminatis, basi angustato-cuneatis, chartaceis, utrinque glabris, nervis lateralibus utroque latere 10–15 fere rectis; inflorescentia lateralis subracemosa, rhachidi 1.8–2 cm. longa, floribus breviter pedicellatis; sepala 2.5 mm. longa subobtusa extus in statu fructifero glabra epunctata; petala 4–4.5 mm. longa lanceolata utrinque glabra epunctata; folliculi 2.3–2.5 cm. longi lateraliter compressi oblique mucronati, basi 5 mm. longe stipitati, pericarpio intus tomentoso.

Tree 6 m. tall, bark of branches light gray, glabrous; leaves 3–5-foliolate, rachis 7–12 cm. long, glabrous; leaflets 8–18 cm. long, 2.2–3.5 cm. broad, oblanceolate, abruptly short-acuminate at apex, narrowed-cuneate at base, chartaceous, dull above, glabrous on both sides; petiolule 2–2.5 mm. long; secondary (lateral) nerves 10–15 on each side, divergent, more or less straight; inflorescence lateral, subracemose, rachis smooth, short, 1.8–2 cm. long; flowers short-pedicellate; sepals 2.5 mm. long, 1–1.25 mm. broad, subobtuse, glabrous (in fruit) on outside, not punctate; petals 4–4.5 mm. long, 1 mm. broad, lanceolate, glabrous on both sides, epunctate; follicle 2.3–2.5 cm. long, 1.5 cm. broad, laterally compressed, obliquely mucronate, stipitate at the base, 5 mm. long; pericarp subligneous, dull orange-brown, glabrous outside, finely lineolate, tomentose within; seed 1.3 cm. long, 0.8 cm. thick, laterally compressed, testa black, shining.—DARIEN: tree 6 m. tall, fruit orange; trail between Pinogana and Yavisa, ca. 15 m., March 17, 1937, *Allen 249* (U. S. Nat. Herb., TYPE, fragment of type in Herb. Field Mus.).

Connarus Allenii is distinct in its narrowly oblanceolate 5-foliolate elongated leaflets and short lateral rachises of the inflorescence. It is related to *C. Turzaninowii,* which differs in its smaller oval leaflets, and to *C. punctatus,* which has the fruit subglabrous instead of tomentose within and broader leaflets.

OXALIDACEAE

Oxalis **coccinea** Woodson & Schery, spec. nov. Suffruticosa ca. 4–5 dm. alta. Caulis basi 2–3 mm. crassus, lignosus brunneus, uno vel duobus ramis magnis basi ex quibus rami minores brevissimi pubescentibus cum pilis adscendentibus oriuntur. Folia inaequilateraliter alternata trifoliolata petiolata. Foliolae facie superiore subglabrae (pilosae juventute), facie inferiore plus minusve dense adpresse pilosae et subglaucoideae; foliola media elliptico-lanceolata, ovato-lanceolata vel elliptica, 15–28 mm. longa, 7–13 mm. lata, apice emarginata vel obtusa, margine paulo undulato, petiolulo 4–5 mm. longo; foliolis lateralibus parvis subsessilibus inaequalibus apice emarginatis, 3–6 mm. longis, 2–4 mm. latis, petiolis plus minusve pubescentibus, 10–15 mm. longis, stipulis destitutis. Pedunculi axillares petiolis longiores, 15–20 mm. longi, pubescentes apice subumbellati; pedicellis brevibus 1–2 mm. longis coccineis pilosis. Sepala coccinea, 4 mm. longa, basi 1 mm. lata, exteriora lanceolata pubescentia. Petala aureo-lutea, ca. 8 mm. longa. Filamenta maiora infra medium appendiculata supra appendicem pubescentia. Styli glabri. Capsula ignota.—BOCAS DEL TORO: near Nievecita, alt. 50 m., Aug. 1940, *Woodson & Schery 1029* (Herb. Missouri Bot. Gard., TYPE).

This species is close to *O. Neaei* DC. but has a more tenuous, less robust habit. The buds and calyces are slightly smaller and tinged a deep red. The young stems and leaflets are also tinged deep red, this being apparent even in the dry plant. The older leaflets are glabrous on the upper surface. The fibrous root system is stout.

RUTACEAE

(C. L. Lundell, Ann Arbor, Mich.)

Zanthoxylum **Scheryi** Lundell, sp. nov. Arbor parva, ramulis crassis, angulatis. Folia imparipinnata; foliola 7 vel 9, petiolulis 5–9 mm. longis; lamina subcoriacea, integra, oblongo-elliptica vel elliptica, 3–7.5 cm. longa, 1.9–4 cm. lata, apice obtusa et emarginata, basi acuta. Inflorescentiae parce puberulae, cymoso-paniculatae, axillares, usque ad 15 cm.

longae. Pedicelli 2.5–3 mm. longi. Sepala 5. Petala 5, glabra, lanceolato-oblonga, 3 mm. longa. Filamenta 2–2.5 mm. longa.

A tree, 6 m. high, branchlets stout, angled, very minutely and sparsely puberulent, essentially glabrous. Leaves odd-pinnate, the petiole up to 6 cm. long, the rachis up to 13 cm. long, the petiole and rachis canaliculate. Leaflets 7 or 9; petiolules canaliculate, 5–9 mm. long; leaf blades subcoriaceous, oblong-elliptic or elliptic, 3–7.5 cm. long, 1.9–4 cm. wide, apex abruptly narrowed, obtuse and emarginate, base acute, decurrent, sparsely puberulent above along the impressed costa, glabrous otherwise, margin entire, paler beneath, costa prominent on under surface, primary lateral veins slender and inconspicuous, 12–14 on each side. Inflorescences cymose-paniculate, axillary, solitary, up to 15 cm. long, including peduncle 9 cm. long, minutely and sparsely puberulent; bracts small, deciduous. Pedicels 2.5–3 mm. long, puberulent. Flowers green-yellow, usually 5-parted. Sepals triangular-ovate, about 0.7 mm. long, acute. Petals glabrous, lanceolate-oblong, 3 mm. long, obtuse and usually emarginate. Filaments 2–2.5 mm. long. Rudimentary pistils usually 5.—CHIRIQUÍ: Potrero Muleto to summit, Volcan de Chiriquí, alt. 3500–4000 m., July 13–15, 1940, *Woodson & Schery 451* (Herb. Univ. Michigan, TYPE).

This remarkable species has affinity to *Z. chiriquinum* Standl. The entire elliptic or oblong-elliptic leaflets and the puberulent panicles up to 15 cm. long are characteristics by which *Z. Scheryi* may be readily separated.

POLYGALACEAE

(S. F. Blake, Washington, D. C.)

POLYGALA FENDLERI Chod. var. HETEROTHRIX Blake.—COCLÉ: between Las Margaritas and El Valle, 1938, *Woodson, Allen & Seibert 1261* (U. S. Nat. Herb.); CHIRIQUÍ: common weed at 800 m., vicinity of El Valle de Antón, alt. 600 m., *Allen 1933* (U. S. Nat. Herb.). Previously known only from Colombia.

POLYGALA GALIOIDES Poir.—COCLÉ: on open llanos, Llano Bonito, north of Las Margaritas, alt. 400–500 m., July 26, 1935, *Seibert 523* (U. S. Nat. Herb.); vicinity of El Valle, alt. 100–800 m., Sept. 5, 1938, *Allen 773* (U. S. Nat. Herb.); CHIRIQUÍ: vi-

cinity of El Valle de Antón, alt. 600 m., *Allen 1932* (U. S. Nat. Herb.). Not previously known north of Colombia, although erroneously recorded by Hemsley from Mexico and Guatemala.

CELASTRACEAE

(C. L. Lundell, Ann Arbor, Michigan)

Maytenus Woodsoni Lundell, Ann. Missouri Bot. Gard. **26**: 291. *pl. 22.* 1939 *(Salacia blepharodes* Pittier, Contr. U. S. Nat. Herb. **18**: 159. 1916, not *Maytenus blepharodes* Lundell; *Maytenus vulcanicola* Standl., Field Mus. Publ. Bot. **22**: 153. 1940).—CHIRIQUÍ: a tree, 2–4 m. high, around El Potrero Camp, Volcan de Chiriquí, at edge of forest, alt. 2800–3000 m., March 10–13, 1911, *H. Pittier 3086* (U. S. Nat. Herb., No. 677476, TYPE of *Salacia blepharodes);* a tree, 3 m. high, Loma Larga to summit, Volcan de Chiriquí, alt. 2500–3380 m., July 4–6, 1938, *Woodson, Allen & Seibert 1065* (Herb. Univ. Michigan, TYPE of *M. Woodsoni);* a tree, 3 m. high, flowers maroon, same locality and date, *Woodson, Allen & Seibert 1088;* near summit, Volcan de Chiriquí, alt. about 3700 m., Feb. 12, 1940, *M. E. Terry 1309* (Field Mus. Herb., TYPE of *Maytenus vulcanicola);* a tree, 4 m. high, flowers maroon, Potrero Muleto to summit, Volcan de Chiriquí, alt. 3500–4000 m., July 13–15, 1940, *Woodson & Schery 398;* a small tree, 6 m. high; same locality and date, *Woodson & Schery 440.*

The types of *Salacia blepharodes* and *Maytenus vulcanicola* do not differ from the type of *M. Woodsoni.*

VITACEAE

Cissus brevipes Morton & Standl.—COCLÉ: north rim of El Valle de Antón, near Cerro Turega, alt. 650–700 m., June 30, 1940, *Woodson & Schery 182.* Previously known from the type locality in Costa Rica.

LOASACEAE

Klaprothia mentzelioides HBK.—CHIRIQUÍ: vicinity of Bajo Chorro, alt. 1900 m., July 20–22, 1940, *Woodson & Schery 650.* New to Panama, known previously from South America and Costa Rica.

BEGONIACEAE

(L. B. Smith & B. G. Schubert, Cambridge, Mass.)

BEGONIA VESTITA C. DC.—CHIRIQUÍ: epiphytic, vicinity of Bajo Chorro, alt. 1900 m., July 20–22, 1940, *Woodson & Schery 621.* Previously known from Costa Rica.

MELASTOMACEAE

(H. A. Gleason, New York)

CENTRONIA PHLOMOIDES Triana—CHIRIQUÍ: vicinity of Bajo Chorro, alt. 1900 m., July 21, 1940, *Woodson & Schery 657.* Previously known only from Costa Rica.

CLIDEMIA SETOSA (Triana) Gleason—COCLÉ: north rim of El Valle, near Cerro Turega, alt. 650–700 m., June 30, 1940, *Woodson & Schery 200.* Previously known from Vera Cruz to Costa Rica.

MICONIA OINOCHROPHYLLA Donn. Sm.—COCLÉ: north rim of El Valle, near Cerro Turega, alt. 650–700 m., June 30, 1940, *Woodson & Schery 174.* Previously known from Guatemala, British Honduras, Honduras, and Colombia.

MICONIA PITTIERI Cogn.—CHIRIQUÍ: vicinity of Bajo Chorro, alt. 1900 m., July 20, 1940, *Woodson & Schery 630.* Previously known from Costa Rica.

OSSAEA MICRANTHA (Sw.) Macf.—CHIRIQUÍ: Quebrada Velo, alt. ca. 1700 m., July 8, 1940, *Woodson & Schery 267.* Guatemala to Peru and the West Indies, but apparently new to Panama.

There are five species of *Blakea* in Costa Rica and Panama which are apparently closely related to each other while distinctly different from the other species of the genus from the same regions. They belong to the section Pyxidanthus, in which the thick leathery bracts are connate for nearly or quite their whole length into two cups, which are scarcely different in length and from which the calyx barely protrudes; the leaves are coriaceous and the flowers unusually large. Another feature of all five is the character of the pubescence. This may be abundantly developed or confined to the leaf-buds alone; it consists of conic many-celled hairs closely aggregated into a

velvety indument, from which project other similar hairs of much larger size, up to 2 mm. long. The differences between them may be summarized in a brief key:

Petals coarsely tuberculate; anthers short-spurred at the base.
  Sepals tipped with a reflexed foliaceous appendage; leaf-blades about twice as long as wide.....*B. calycosa* Gl.
  Sepals unappendaged; leaf-blades cordate at base, about as wide as long .....*B. tuberculata* Donn. Sm.
Petals not tuberculate; anthers rounded at the base.
  Younger parts, except the leaf-buds, glabrous or nearly so; leaf-blades 5-nerved, with an additional marginal pair.
    Leaf-blades rounded at the base, the secondary veins spreading at right angles; hypanthium and calyx together 15–18 mm. long.....
    .....*B. intercepta* sp. nov.[1]
    Leaf-blades cuneate at the base, the secondary veins spreading at an angle of 70°; hypanthium and calyx together 20–25 mm. long.....*B. Woodsoni* Gl.
  Young stems, petioles, leaf-veins beneath, peduncles, bracts, and sepals densely pubescent; leaves 5-nerved with an additional marginal pair.....
  .....*B. brunnea* sp. nov.

Blakea **brunnea** Gleason, sp. nov. Arbor; rami subteretes, petioli, venae subtus, pedunculi, bracteae, et sepala dense brunneo-velutini. Petioli validi 3–6 cm. longi. Laminae subcoriaceae, ellipticae, usque 20 cm. longae 12 cm. latae, apice breviter apiculatae, basi late rotundatae, supra glabrae opacae venis impressis, subtus brunneae, 5-nerviae jugo marginali neglecto, venis dense pubescentibus valde elevatis, venulis tenuiter pubescentibus sub angulo fere recto divergentibus. Pedunculi solitarii crassissimi 15–20 mm. longi. Bracteae toto connatae, involucram subcylindricam 25 mm. longam formantes. Flores 6-meri. Hypanthium glabrum. Calyx breviter 6-lobatus, extra pubescens. Petala staminaque matura non visa. Antherae dolabriformes 7 mm. longae. Stylus 3 cm.

[1] Blakea **intercepta** Gleason, sp. nov. Arbor parva; rami vix cogniti ut videtur ancipites fere glabri. Petioli subglabri 3–4 cm. longi. Laminae ellipticae, usque 20 cm. longae 11 cm. latae, obtusae, apiculatae, basi late acutae, 5-nerviae, jugo marginali neglecto, utrinque fere glabrae, venis lateralibus sub angulo fere recto divergentibus. Inflorescentia floresque ignoti. Bracteae connatae hypanthium amplectentes. Hypanthium glabrum circa 10 mm. longum. Calyx glaber circa 6 mm. longus, indistincte lobatus.

Type collected in Costa Rica by Otto Kuntze, June 20, 1874, and labeled in Kuntze's hand "*Blakea multiflora* Don. *Topobea* Triana."

longus glaber attenuatus.—CHIRIQUÍ: vicinity of Bajo Chorro, alt. 1900 m., July 20–22, 1940, *Woodson & Schery 615* (Herb. New York Bot. Gard., TYPE).

CONOSTEGIA **chiriquensis** Gleason, sp. nov. Arbor glaberrima, ut videtur parva, ramis crassis rotunde 4-angulatis cicatricibus foliorum rotundis notatis. Petioli gracili, usque 3 cm. longi. Laminae subcoriaceae, ellipticae, usque 12 cm. longae 6 cm. latae, abrupte breviterque caudato-acuminatae, remote denticulatae, basi abrupte cuneatae, 3-nerviae vel vix 3-pli-nerviae, jugo marginali neglecto, venis secundariis sub angulo 70° divergentibus supra obsoletis. Panicula circa 1 dm. longa, a basi ramosa, pedicellis 3–5 mm. longis. Alabastra 9–10 mm. longa in specimine typico, in altero usque 14 mm., abrupte acuminata in rostrum crasse subulatum 2 mm. longum. Hypanthium late poculiforme, 4 mm. longum. Petala late rhomboidea, alba, 12 mm. longa, valde asymmetrica, latere uno in lobum triangularem producto, altero rotundato. Antherae oblongae, obtusae, 2-loculares, 2.8 mm. longae; connectivum dorse proper basin tumidum. Ovarium 6-loculare, fere toto inferum, truncato-conicum; stylus crassus, 4.4 mm. longus; stigma hemisphaericum, 1.5 mm. latum.—CHIRIQUÍ: vicinity of Finca Lérida, alt. 1750 m., July 11, 1940, *Woodson & Schery 376* (Herb. New York Bot. Gard., TYPE); vicinity of Callejon Seco, Volcan de Chiriquí, alt. 1700 m., July 17, 1940, *Woodson & Schery 479* (Herb. New York Bot. Gard., COTYPE).

The closest relatives of *C. chiriquensis* are two Costa Rican species, *C. rhodopetala* Donn. Sm., with more sharply angled branches, longer shining leaves with the secondary veins spreading at right angles, and much smaller petals, and *C. Pittierii* Cogn., with smaller, thinner, proportionately wider, distinctly 3-pli-nerved leaves.

MERIANIA (§ DAVYA) **panamensis** Gleason, sp. nov. Arbor glaberrima 20 m. alta, ramis junioribus subteretibus ad nodos paullo incrassatis. Petioli atropurpurei 25–40 mm. longi. Laminae chartaceae, ovato-ellipticae, usque 13 cm. longae 7 cm. latae, in cuspem brevem obtusam rotundatae, integrae,

basi late cuneatae, 5-nerviae, venulis creberrime reticulatis. Panicula magna ramosa multiflora; flores 5-meri breviter (5 mm.) pedicellati ad apicem ramulorum. Hypanthium late poculiforme 6.5 mm. latum. Calyx patulus, 3.5–4 mm. latus, limbo vix 5-lobato. Petala late et inaequilateraliter cuneato-obovata, 3 cm. longa. Stamina episepala: filamenta 17 cm. longa; antherae crasse subulatae, arcuatae, 7 mm. longae; connectivum non appendiculatum, supra basin tumidum. Stamina epipetala: filamenta 12 mm. longa; antherae graciliter subulatae, valde arcuatae, 12–13 mm. longae; connectivum ad basin productum in appendicem dorsalem linearem apice dilatatam 4 mm. longam. Ovarium superum; stylus gracilis, 13 mm. longus; stigma punctiforme.—CHIRIQUÍ: Casita Alta to Cerro Copete, Volcan de Chiriquí, alt. 2300–3300 m., July 10, 1940, *Woodson & Schery 361* (Herb. New York Bot. Gard., TYPE).

ARALIACEAE

(A. C. Smith, Jamaica Plain)

SCHEFFLERA **epiphytica** A. C. Smith, sp. nov. Frutex epiphyticus circiter 2 m. altus ubique inflorescentia excepta glaber, ramulis crassis subteretibus pallidis striatis; foliis simplicibus, petiolis crassis ad 15 mm. longis, inferne late alatis, superne subteretibus et leviter canaliculatis, medium versus ligula coriacea oblongo-lineari ad 20 mm. longa persistente ornatis; laminis chartaceis siccitate viridi-olivaceis elliptico-oblongis, 18–23 cm. longis, 9–11 cm. latis, basi leviter cordatis vel rotundatis, apice abrupte acuminatis (acumine ad 8 cm. longo acuto), margine integris et saepe leviter revolutis, costa utrinque prominente, nervis secundariis utrinsecus 12–16 subpatentibus marginem versus anastomosantibus supra paullo subtus valde prominulis, venulis saepe utrinque prominulis; inflorescentia composito-paniculata, rhachi ramulisque gracilibus striatis mox glabris, pedunculo subnullo, rhachi 2–4 cm. longa, ramulis paucis ad 35 cm. longis (stipitibus ad 10 cm. longis inclusis) bracteis chartaceis oblongis acutis 22–30 mm. longis glabris subtentis; pedunculis numerosissimis patentibus gracilibus sub anthesi ad 9 mm. sub fructu ad 15 mm. longis

minute puberulis mox glabris; floribus 5–8 per umbellam, pedicellis gracilibus primo puberulis sub anthesi ad 3 mm. sub fructu ad 6 mm. longis, bracteis basi pedicellorum membranaceis acutis deltoideis circiter 0.7 mm. longis; calyce levi obconico sub anthesi 1–1.5 mm. longo et circiter 2 mm. diametro, limbo minuto membranaceo, lobis nullis vel obscure apiculatis; petalis membranaceis glabris in calyptram mox caducam connatis, calyptra semiglobosa circiter 2 mm. longa et 2.5 mm. diametro, apice obtuse umbonata, conspicue reticulato-nervata; staminibus 5, filamentis gracilibus 0.4–0.7 mm. longis, antheris deltoideo-ovoideis circiter 1.5 mm. longis, basi subcordatis, apice obtusis, stylis 5 in columnam carnosam conicam cohaerentibus, apice minute liberis, loculis et ovulis 5; fructibus subglobosis ad 3.5 mm. diametro conspicue 5-costatis disco et stylorum columna coronatis.—COCLÉ: epiphytic shrub 2 m. tall, flowers white; hills north of El Valle de Antón, vicinity of La Mesa, alt. 1000 m., Jan. 21, 1941, *Allen 2344* (U. S. Nat. Herb., Nos. 1,806,122 and 1,806,123, TYPE); same locality, *Allen 2723* (Arn. Arb.).

This remarkable plant is at once distinguished from other American species of *Schefflera* by its simple leaves; to the best of my knowledge only two Old World species of the genus with simple leaves are known. The plant is certainly a member of the genus *Schefflera (nomen conservandum propositum;* see A. C. Smith, in Trop. Woods **66**: 5. 1941), agreeing in such unmistakable characters as the conspicuous petiolar ligules, the paniculately umbelliferous inflorescences, and the calyptrate petals. Since both simple and compound leaves are found in such genera as *Oreopanax* and *Didymopanax,* the discovery of a simple-leaved American species of *Schefflera* is not entirely surprising.

VACCINIACEAE

(A. C. Smith, Jamaica Plain, Mass.)

Recent collectors in Panama have obtained several plants of the tribe Thibaudieae of unusual interest; in the present paper eight species and one genus are proposed as new, while five others are reported from Panama for the first time. The

collectors whose plants are cited are Paul H. Allen, M. E. Davidson, C. and W. von Hagen, and R. E. Woodson and R. W. Schery. Their plants have been seen in the following herbaria: Arnold Arboretum (A); Missouri Botanical Garden (Mo); New York Botanical Garden (NY); U. S. National Herbarium (US); the parenthetical letters indicate the place of deposit.

Macleania **epiphytica** sp. nov. Frutex epiphyticus 1 m. altus ubique praeter corollae lobas glaber, ramulis cinereis teretibus gracilibus; petiolis rugosis crassis 4–6 mm. longis; laminis coriaceis siccitate olivaceis oblongo-ellipticis, 5–8 cm. longis, 2–3 cm. latis, basi rotundatis vel late obtusis, apice obtusis, margine integris et incrassatis, 5-pli-nerviis, nervis prope basim orientibus supra subplanis vel prominulis subtus leviter elevatis, costa subtus subprominente, rete venularum utrinque inconspicue prominulo; inflorescentiis apicem ramulorum versus axillaribus fasciculatis vel obscure racemosis 2–4-floris, floribus bracteis minutis subtentis; pedicellis crassis 6–11 mm. longis, apicem versus leviter incrassatis, paullo supra medium bracteolis papyraceis ovato-deltoideis acutis circiter 1.5 mm. longis et latis bibracteolatis; calycis tubo obprismatico sub anthesi circiter 3.5 mm. longo obscure 5-angulato, limbo suberecto lobis late deltoideis acutis circiter 1 mm. longis et 2.5 mm. latis inclusis circiter 2 mm. longo, sinibus rotundatis; corolla tenuiter carnosa cylindrica sub anthesi 17–18 mm. longa et basim versus circiter 5 mm. diametro, apicem versus contracta, lobis 5 deltoideis subacutis circiter 1.5 mm. longis intus albo-puberulis; staminibus 10, filamentis membranaceis liberis ligulatis circiter 3 mm. longis, antherarum loculis 4–4.5 mm. longis, tubulo unico rigido circiter 3 mm. longo rima ovali 2–2.5 mm. longa dehiscente; stylo corollam subaequante, stigmate inconspicuo.—COCLÉ: epiphytic shrub 1 m. high; corolla scarlet, tipped with green; hills north of El Valle de Antón, alt. 1000 m., June 23, 1940, *Allen 2171* (A, TYPE).

Macleania epiphytica, related to those species of the genus with a single anther-tubule and glabrous corollas, sharply differs from them in having its filaments separate rather than connate in a tube. In foliage, the new species suggests *M. com-*

pacta A. C. Smith and *M. insignis* Mart. & Gal., but it has larger flowers than the former and smaller flowers than the latter.

PSAMMISIA **panamensis** sp. nov. Frutex epiphyticus ad 50 cm. altus ubique praeter florum filamentas glaber, ramulis crassis fuscis apicem versus conspicue complanatis; petiolis rugosis crassis (circiter 3 mm. diametro) subteretibus 8–10 mm. longis; laminis tenuiter coriaceis siccitate fuscis oblongo-lanceolatis, 26–34 cm. longis, 5.5–7.5 cm. latis, basi subattenuatis, apice gradatim acuminatis, margine integris et anguste revolutis, pinnatinerviis, costa supra elevata subtus prominente, nervis secundariis utrinsecus 8–10 supra prominulis subtus acute elevatis marginem versus conspicue anastomosantibus, inferioribus adscendentibus superioribus patentibus, rete venularum utrinque prominulo; inflorescentiis axillaribus breviter racemosis sub anthesi ut videtur 6–8-floris, pedunculo subnullo, rhachi 6–10 mm. longa angulata, pedicellis crassis 8–12 mm. longis bracteis papyraceis ovatis subacutis circiter 1.5 mm. longis subtentis, basim versus bracteolis ut bracteis similibus bibracteolatis, apicem versus paullo incrassatis; calyce late campanulato sub anthesi 7–8 mm. longo, tubo 4–5 mm. longo et summo 5–7 mm. diametro, limbo tenuiter coriaceo suberecto circiter 3 mm. longo, lobis 5 deltoideis acutis circiter 2 mm. longis et 3 mm. latis; corolla tenuiter carnosa (basim versus tenuiore) truncato-conica sub anthesi 6–7 mm. longa et basi circiter 5 mm. diametro, apicem versus contracta, lobis 5 deltoideis subacutis circiter 1 mm. longis et latis; staminibus 10, filamentis submembranaceis ligulatis 1.5–2 mm. longis, margine puberulente-ciliolatis, apicem versus angustatis, connectivis angustis alternatis obscure bicalcaratis vel interdum ecalcaratis, antheris rigidis 3.5–4 mm. longis, loculis basi conspicue incurvatis, tubulis cylindrico-conicis circiter 1.5 mm. longis rimis elongatis ovalibus dehiscentibus; stylo corollam subaequante, stigmate inconspicuo.—COCLÉ: epiphytic shrub 50 cm. high; hills north of El Valle de Antón, alt. 1000 m., June 23, 1940, *Allen 2152* (A, TYPE).

Psammisia panamensis is the second species of the genus thus far known from North America, but it is not of the rela-

tionship of *P. ramiflora* Kl. of Costa Rica and Panama. The new species appears to be closely related only to the Peruvian *P. globosa* A. C. Smith, the two being essentially identical in foliage. *Psammisia panamensis,* however, in comparison with its ally, has a substantially larger calyx with conspicuous lobes, a larger and conical (rather than subglobose) corolla, and obviously larger stamens with less conspicuous and essentially unspurred connectives.

THIBAUDIA COSTARICENSIS Hoer. Bot. Jahrb. **42**: 311. 1909; A. C. Smith, Contr. U. S. Nat. Herb. **28**: 425. 1932.—CHIRIQUÍ: tree to 10 m. high, common in rain-forest; corollas pink and white; Boquete Region, Cerro Horquete, alt. about 2000 m., *von Hagen 2023* (A, NY); epiphytic shrub in rain-forest; calyx rose; corolla white; Boquete Region, Bajo Chorro, alt. about 1800 m., *Davidson 380* (A).

The species has previously been known only from Costa Rica, elevations up to 1600 m. only having been reported.

ANTHOPTEROPSIS A. C. Smith, gen. nov.

Frutices, foliis breviter petiolatis, laminis subcoriaceis; inflorescentiis terminalibus vel axillaribus breviter racemosis, floribus pedicellatis bracteis subtentis; calyce cum pedicello articulato alis 5 conspicuis e basi ad apicem adscendentibus lobis alternatis praedito, dentibus 5 inconspicuis; corolla carnosa cylindrica 5-lobata; staminibus 10 aequilongis, filamentis membranaceis, antheris basim versus dorsifixis, loculis leviter granulatis basi paullo incurvatis, connectivis angustatis alternatim summo loculorum calcare mediano unicalcaratis, tubulis 2 ad basim distinctis flexibilibus per rimas ovales introrses elongatas dehiscentibus; ovario in calyce immerso disco annulari complanato coronato, loculis 5, placentis magnis, ovulis numerosis, stylo filiformi corollam subaequante, stigmate minute subcapitato.

ANTHOPTEROPSIS **insignis** sp. nov. Frutex ad 4 m. altus ubique praeter inflorescentiae partes et ramulos juveniles inconspicue puberulos glaber, ramis ramulisque teretibus cinereis gracilibus leviter rimosis juventute fuscis angulatis;

petiolis paullo incrassatis supra complanatis 2–3 mm. longis; laminis elliptico-oblongis, (3–)4–6 cm. longis, (1.5–)2–3 cm. latis, basi anguste rotundatis, apice obtusis vel obtuse cuspidatis, margine integris et anguste recurvatis, 5-pli-nerviis, nervis paullo supra basim orientibus adscendentibus utrinque valde prominulis, costa subtus valde elevata, rete venularum utrinque leviter prominulo; inflorescentiis terminalibus vel raro apicem ramulorum versus axillaribus, 5–12-floris, floribus bracteis papyraceis deltoideis circiter 1.5 mm. longis subacutis inconspicue ciliolatis subtentis, rhachi subtereti ad 1 cm. longa; pedicellis subteretibus rugulosis crassis 15–20 mm. longis superne gradatim incrassatis et saepe inconspicue puberulis, medium versus bracteolis ut bracteis sed circiter 1 mm. longis bibracteolatis; calyce carnoso subgloboso sub anthesi alis inclusis 8–10 mm. diametro, tubo limbum longitudine subaequante, limbo erecto, dentibus minute apiculatis, alis carnosis (vel siccitate submembranaceis) 2–3 mm. latis, apicibus alarum dentes 1 mm. excedentibus; corolla sub anthesi 16–19 mm. longa et 4–5 mm. diametro, inconspicue 5-angulata, superne pilis fuscis debilibus circiter 0.3 mm. longis parce pilosa demum glabrescente, lobis deltoideis apiculatis circiter 1 mm. longis et 2–2.5 mm. latis, sinibus acutis; staminibus circiter 9 mm. longis, filamentis distinctis basim corollae saepe cohaerentibus pallidis ligulatis circiter 3 mm. longis et basi 1.3 mm. latis, superne dorso pallide hirsutis, antheris circiter 7 mm. longis, loculis 4–5 mm. longis, connectivis pallidis, calcare circiter 0.5 mm. longo, tubulis quam loculis paullo angustioribus acutis.—COCLÉ: large straggling shrub 4 m. high, the stem 15 cm. in diameter, calyx fleshy, pink, corolla yellow; hills south of El Valle de Antón, alt. about 700 m., May 9, 1941, *Allen 2500* (A, TYPE, Mo).

This specimen, one of many remarkable plants collected in Coclé by Mr. Allen, is not readily placed in any existing genus. At first glance (as indicated by my generic name) it suggests *Anthopterus* Hook., but closer examination indicates that it differs in many essential features. Other genera showing certain points of relationship are *Thibaudia* R. & P., *Macleania*

	Macleania	*Psammisia*	*Anthopterus*	*Thibaudia*	*Anthopteropsis*
Calyx:	Articulate with pedicel; sometimes winged to sinuses (wings in *M. pentaptera* Hoer. exceeding the inconspicuous lobes).	Articulate with pedicel; not winged.	Continuous with pedicel; winged to sinuses, but with obvious lobes exceeding the wings.	Usually articulate with pedicel; rarely narrowly winged to sinuses.	Articulate with pedicel; conspicuously winged to sinuses, the wings produced distally and exceeding the inconspicuous lobes.
Corolla:	Tubular or urceolate.	Tubular or urceolate.	Conspicuously winged.	Tubular.	Tubular.
Anthers:	Locules strongly granular; spurs lacking; tubules rigid.	Locules strongly granular; spurs present (but lateral at apex of connective, not median); tubules rigid.	Locules finely granular; spurs lacking; tubules flexible.	Locules finely granular; spurs lacking (vestigial in *T. cupatensis* Huber); tubules flexible.	Locules finely granular; spurs present on alternate connectives, dorsal, median; tubules flexible.

Hook., and *Psammisia* Kl. The accompanying table summarizes the more important points of difference among these genera, as regards their relationship to *Anthopteropsis*.

From this summary it is perceived that *Anthopteropsis* has some essential characters in common with each of the mentioned genera. Its calyx is faintly suggestive of that of *Macleania pentaptera* Hoer., but staminal characters definitely remove it from that genus. The spurs of the connectives of *Psammisia* are of quite a different type from those of the new genus, and in many other respects *Psammisia* may be excluded as a close relative. The conspicuously winged corollas of *Anthopterus* amply differentiate that genus. The species of *Thibaudia* have no suggestion of accentuated calyx-wings, and the vestigial connective-spurs of *T. cupatensis* Huber are hardly of the same type as the spurs of *Anthopteropsis*. Nevertheless, *Thibaudia* may be the closest ally of the new genus. I have already discussed (in Bull. Torrey Bot. Club **63**: 316. 1936) the several elements which have in the past been referred to *Thibaudia,* and it hardly seems advisable to expand that generic concept further by dubious inclusion of the present plant.

CAVENDISHIA **gaultherioides** sp. nov. Frutex epiphyticus ad 1 m. altus ubique glaber, ramulis gracilibus subteretibus cinereis vel purpurascentibus; foliorum laminis subsessilibus (petiolis crassis ad 3 mm. longis et diametro) chartaceis vel tenuiter coriaceis siccitate fusco-olivaceis bullatis ovatis vel suborbicularibus, 5–12 cm. longis, 4–10 cm. latis, basi rotundatis vel leviter cordatis, apice obtusis vel rotundatis, margine integris et anguste revolutis, pinnatinerviis, costa supra basim versus elevata subtus prominente, nervis secundariis utrinsecus 5–10 inferioribus adscendentibus superioribus brevibus patentibus, omnino supra in sulcis prominulis subtus prominentibus marginem versus nervo marginali conjunctis, rete venularum utrinque leviter prominulo; inflorescentiis axillaribus congestis breviter racemosis basi bracteis deciduis suffultis, rhachi crassa (1.5–2 mm. diametro) sub anthesi ad 2 cm. longa 5–12 flora; bracteis floriferis papyraceis concavis ellip-

tico-oblongis vel suborbicularibus 6–10 mm. longis et latis, basi paullo angustatis, apice acutis vel rotundatis, conspicue et copiose flabellato-nerviis (nervis utrinque prominulis), margine saepe minute glanduloso-ciliolatis; pedicellis inconspicuis crassis circiter 1 mm. longis bibracteolatis, bracteolis ut bracteis sed angustioribus vel interdum reductis; calyce campanulato circiter 6 mm. longo, tubo circiter 2 mm. longo et 3–4 mm. diametro, limbo erecto-patente summo 4–5 mm. diametro conspicue nervato, lobis 5 ovato-deltoideis, circiter 1.5 mm. longis et 2–3 mm. latis, apice apiculatis, margine glanduloso-ciliolatis, basi saepe minute imbricatis, sinibus acutis; corolla tenuiter carnosa cylindrica 7–10 mm. longa, 3–4.5 mm. diametro, supra medium interdum inconspicue glandulosa, lobis 5 oblongo-deltoideis acutis; staminibus 10 subaequalibus, filamentis membranaceis ligulatis alternatim 2–2.5 mm. et 3–4 mm. longis, antheris alternatim circiter 6 mm. et 5 mm. longis, tubulis quam loculis circiter duplo longioribus; stylo gracili corollam subaequante, stigmate irregulariter peltato.—COCLÉ: epiphytic shrub 50 cm. high, the bracts pink, the corollas white; hills north of El Valle de Antón, alt. 1000 m., *Allen 2170* (A); epiphytic shrub 1 m. high, the bracts shell-pink, the corollas greenish yellow; vicinity of La Mesa, north of El Valle de Antón, alt. 1000 m., April 12, 1941, *Allen 2375* (A, TYPE, Mo).

Cavendishia gaultherioides is a remarkably distinct species, characterized by its subsessile pinnate-nerved leaf-blades and its compact inflorescences with conspicuously nerved and often glandular-ciliolate bracts and bracteoles, subsessile flowers, and narrowly imbricate or at least contiguous calyx-lobes. Its only close relatives are *C. complectens* Hemsl. and *C. compacta* A. C. Smith; the former differs in its cordate-based amplexicaul leaf-blades, longer inflorescences, more numerous flowers, obvious pedicels, and its larger eglandular bracts; the latter differs in its larger pli-nerved caudate-acuminate petiolate leaf-blades, elongate inflorescences, large bracts, obviously pedicellate and larger flowers, etc.

CAVENDISHIA **Allenii** sp. nov. Frutex epiphyticus ad 1 m. altus ubique (corolla non visa forsan excepta) glaber, ramulis

subteretibus fusco-cinereis; foliorum laminis subsessilibus (petiolis incrassatis rugulosis 2–3 mm. longis) coriaceis siccitate fusco-olivaceis ovatis, 6.5–10 cm. longis, 4–7 cm. latis, basi rotundatis vel inconspicue subcordatis, apice obtusis vel subrotundatis, margine integris et valde recurvatis, 5-plinerviis, costa supra paullo elevata vel subplana subtus prominente nervis lateralibus utrinsecus 3–5 inconspicuis superne praedita, nervis secundariis e basi orientibus adscendentibus utrinque elevatis, venulis immersis; inflorescentiis axillaribus racemosis, rhachi angulata crassa (1.5–3 mm. diametro) 2.5–6 cm. longa multiflora, floribus congestis; bracteis floriferis papyraceis concavis ellipticis, 17–20 mm. longis, 10–15 mm. latis, apice acutis, margine integris, conspicue et copiose flabellato-nervatis (nervis utrinque prominulis); floribus subsessilibus, pedicellis inconspicuis ad 1 mm. longis bibracteolatis, bracteolis ut bracteis sed angustioribus et paullo brevioribus; calycis tubo post anthesin subgloboso levi 3–5 mm. diametro, limbo erecto papyraceo tubuloso lobis inclusis 7–8 mm. longo basi 2.5–3 mm. apice circiter 4 mm. diametro conspicue striato-nervato, lobis 5 oblongo-deltoideis 2–2.5 mm. longis et latis, apice apiculatis, margine interdum inconspicue glanduloso-ciliolatis, sinibus acutis; fructibus subglobosis ad 15 mm. diametro calycis limbo conspicuo coronatis, pericarpio tenui ut videtur submembranaceo, seminibus numerosis ovoideis circiter 1 mm. longis conspicue scrobiculatis.—COCLÉ: epiphytic shrub 1 m. high; fruit blue; along trail to Las Minas, north of El Valle de Antón, alt. 1000 m., May 10, 1941, *Allen 2471* (A, TYPE).

Although no corollas are available, the cited collection so obviously represents a new species that I venture to describe it. *Cavendishia Allenii* is at once distinguished by its subsessile leaves with rounded bases and obtuse apices, its subsessile flowers, and its papyraceous and conspicuously nerved bracts, bracteoles, and calyx limb, the latter being tubular and elongated. The mature fruit has a remarkably thin pericarp for the genus. The new species is suggestive of the preceding *(C. gaultherioides)* in its subsessile flowers and conspicuously

nerved bracts and bracteoles, but its calyces and foliage are so different that the close alliance of the two is dubious.

Cavendishia **calycina** sp. nov. Frutex epiphyticus ubique glaber, ramulis gracilibus subteretibus cinereis; petiolis rugosis subteretibus crassis (ad 2 mm. diametro) 4–7 mm. longis; laminis coriaceis elliptico-oblongis, 7–11 cm. longis, 3–5 cm. latis, basi rotundatis vel late obtusis, apice acuminatis (acumine gracili ad 2 cm. longo acuto), margine integris et leviter recurvatis, subtus minute nigro-punctatis, 5- vel 7-pli-nerviis, nervis adscendentibus prope basim orientibus cum costa supra leviter impressis subtus prominentibus, exterioribus debilibus, rete venularum supra prominulo subtus subimmerso; inflorescentiis apicem ramulorum versus axillaribus breviter racemosis ut videtur 8–12-floris, rhachi circiter 3 mm. crassa et 10–12 mm. longa; bracteis floriferis papyraceis vel submembranaceis oblongo-ellipticis, 28–30 mm. longis, 16–18 mm. latis, apice rotundatis, margine integris; pedicellis crassis 4–5 mm. longis basim versus bracteolas 2 circiter 4 mm. longas gerentibus; calyce campanulato 7–8 mm. longo, tubo brevissimo circiter 4 mm. diametro, limbo erecto papyraceo lobis inclusis circiter 6 mm. longo, lobis 5 oblongis, 3–3.5 mm. longis, 2.5–3 mm. latis, apicem versus scariosis, apice calloso-apiculatis, margine leviter undulatis et saepe contiguis, sinibus acutis vel anguste rotundatis; corolla tenuiter carnosa cylindrica, sub anthesi 16–18 mm. longa et 3–4 mm. diametro, lobis parvis deltoideis subacutis; staminibus 10 subaequalibus quam corolla paullo brevioribus, filamentis chartaceis nigrescentibus ligulatis alternatim circiter 3 mm. et 5 mm. longis apicem versus obscure cinereo-pilosis, connectivis angustis nigrescentibus, antheris alternatim circiter 14 mm. et 12 mm. longis, tubulis quam loculis circiter duplo longioribus; stylo gracili corollam subaequante, stigmate peltato.—chiriquí: epiphyte, in rain-forest, corolla red, tipped with white; Boquete District, Bajo Chorro, alt. about 1800 m., Jan. 18, 1938, *Davidson 157* (A, type).

Although the cited specimen bears only one disintegrated inflorescence and two flowers, the material is quite adequate to in-

dicate that a very distinct new species is represented. While the calyx-lobes are not exactly "imbricate," as indicated in my key (Contr. U. S. Nat. Herb. **28**: 463. 1932) for *C. compacta* A. C. Smith, this Colombian species nevertheless appears to be the closest ally of the new species. *Cavendishia calycina* differs from *C. compacta* in its smaller leaf-blades with the nerves oriented nearer the base, its more compact inflorescences, thinner and larger bracts, and smaller calyx, especially as regards the lobes, which are erect but not imbricate nor thickened at the margin.

CAVENDISHIA CAPITULATA Donn. Sm. Bot. Gaz. **25**: 147. 1898; A. C. Smith, Contr. U. S. Nat. Herb. **28**: 450. 1932.—CHIRIQUÍ: alt. 1500–1900 m., *Allen 1434* (Mo), *Davidson 92* (A), *120* (A), *Woodson & Schery 574* (NY), *576* (Mo), *632* (NY); COCLÉ: alt. 1000 m., *Allen 2721* (A).

Although known from abundant material collected in Costa Rica, the above-cited specimens are apparently the first of the species from Panama.

CAVENDISHIA LONGIFLORA Donn. Sm. Bot. Gaz. **37**: 420. 1904; A. C. Smith, Contr. U. S. Nat. Herb. **28**: 452. 1932.—COCLÉ: epiphytic shrub, the bracts and flowers bright rose; hills north of El Valle de Antón, alt. 650–1000 m., *Woodson & Schery 193* (NY); epiphytic shrub, the branches 2 m. long; bracts rose-pink, the corollas white; *Allen 2207* (A, Mo).

This species has previously been known only from the type locality near La Palma, San José, Costa Rica. A recently collected specimen from the Province of Chiriquí in Panama, *Seibert 176* (US), also doubtless represents the species, but it is a form with very narrow leaves.

CAVENDISHIA STENOPHYLLA A. C. Smith, Ann. Missouri Bot. Gard. **27**: 327. 1940.—COCLÉ: epiphytic shrub 1 m. high; flowers purple; hills north of El Valle de Antón, alt. 1000 m., *Allen 2162* (A); shrub 1.5 m. high, growing on steep banks along trails; flowers deep purple; vicinity of La Mesa, north of El Valle de Antón, alt. 1000 m., *Allen 2373* (A, Mo).

The cited specimens are the second and third collections of

the species and precisely match the type, *Allen 1880*, from the Province of Panama. The following description may now be added to the original:

Rhachis inflorescentiae ad 10 cm. longa, corolla tenuiter carnosa cylindrica sub anthesi 16–19 mm. longa et 4–5 mm. diametro, basi paullo contracta, extus pilis circiter 0.3 mm. longis laxe cinereo-puberula, lobis 5 deltoideis subacutis circiter 1 mm. longis et 2 mm. latis; staminibus subaequalibus, filamentis submembranaceis ligulatis distaliter parce puberulis alternatim circiter 2 mm. et 5 mm. longis, antheris gracilibus alternatim circiter 16 mm. et 13 mm. longis, tubulis quam loculis 1.5–2-plo longioribus; stylo gracili corollam subaequante, stigmate obscuro.

Cavendishia **chiriquiensis** sp. nov. Frutex epiphyticus gracilis, ramulis glabris fuscis subteretibus vel apicem versus saepe leviter complanatis; petiolis gracilibus subteretibus 4–7 mm. longis, juventute cinereo-puberulis mox glabris; laminis glabris chartaceis ovatis, 4.5–6 cm. longis, 1.5–2 cm. latis, basi obtusis, apice longe caudato-acuminatis (acumine gracili 1.5–2 cm. longo acuto), margine integris et saepe leviter recurvatis, 3(obscure 5)-pli-nerviis, costa supra paullo impressa subtus elevata, nervis secundariis prope basim orientibus adscendentibus supra subplanis vel leviter impressis subtus prominulis, rete venularum supra saepe prominulo subtus immerso; inflorescentiis praeter corollas glabris axillaribus vel subterminalibus racemosis 6–8-floris, basi decidue bracteatis, pedunculo brevi, rhachi gracili leviter angulata 1.2–3.5 cm. longa; bracteis floriferis conspicuis papyraceis vel submembranaceis obovato-oblongis, 16–25 mm. longis, 4–10 mm. latis, basi angustatis, apice obtusis, utrinsecus glandulas circiter 10 margine gerentibus; pedicellis rectis 4–6 mm. longis basim versus bibracteolatis (bracteolis papyraceis oblongo-lanceolatis 1.5–2 mm. longis saepe glandulosis) apicem versus glandulas paucas magnas (0.2–0.3 mm. diametro) sessiles gerentibus; calyce 3.5–4 mm. longo, tubo cylindrico 2–3 mm. diametro basi obscure apophysato et velut pedicellis glanduloso, limbo papyraceo suberecto 2–3 mm. longo, lobis 5 deltoideis subacutis 0.7–1 mm.

longis textura omnino glandulosis, sinibus complanatis; corolla (unica immatura visa) cylindrica albo-puberulente; stylo persistente gracili 20–22 mm. longo, stigmate obscure peltato. —CHIRIQUÍ: epiphytic shrub, the bracts rose, the flowers pale lavender-blue; vicinity of Bajo Chorro, alt. 1900 m., July 20–22, 1940, *Woodson & Schery 688* (NY, TYPE); Boquete Region, *von Hagen 2033* (A, NY).

Although the cited specimens lack mature corollas, I have no doubt that a new species is represented, as the essential characters of the inflorescence are found in the bracts, pedicels, and calyces. From the persistent styles, one may assume that the corolla is about 2 cm. long.

Cavendishia chiriquiensis is a very distinct species, characterized by its small caudate-acuminate, few-nerved leaf-blades, its glandular-margined bracts, and its glandular calyces and pedicels. Among Central American species, it is suggestive only of *C. Endresii* Hemsl., from which it differs in the above-mentioned characters, its shorter pedicels, more conspicuous bracteoles, and presumably longer corollas. Other relatives are the Colombian *C. rhynchophylla* A. C. Smith and *C. Purdiei* A. C. Smith, but these differ in obvious features of foliage and inflorescence.

CAVENDISHIA MICONIOIDES A. C. Smith, Contr. U. S. Nat. Herb. **28**: 503. 1932. (*Thibaudia melastomoides* H. B. K. Nov. Gen. & Sp. **3**: 272. 1818; *Cavendishia melastomoides* Hoer. Bot. Jahrb. **42**: 279. 1909; non Hemsl. 1881).—CHIRIQUÍ: tree 5 m. high; corolla red, white-tipped; between Casita Alta and Cerro Copete, alt. 2300–3300 m., *Woodson & Schery 357* (NY).

The species has previously been known from numerous collections in Colombia and Ecuador. The cited specimen from Panama has the leaves slightly smaller than the average of those from South America, but I find no consequential separating characters.

CAVENDISHIA PUBESCENS (H. B. K.) Hemsl. Biol. Centr.-Amer. Bot. **2**: 273. 1881; A. C. Smith, Contr. U. S. Nat. Herb. **28**: 485. 1932.—CHIRIQUÍ: shrub 2–3 m. high; bracts pale pink;

corolla white, faintly pink-tinged; Boquete Region, alt. about 1150 m., *Davidson 649* (A).

In making the above-cited combination, Hemsley cited *Seemann 1613* from Boquete, but, since I had not seen any material of the species from Panama in 1932, I did not include Panama in the range of this common South American species.

Satyria **Allenii** sp. nov. Frutex epiphyticus multiramosus ubique praeter inflorescentiam glaber, ramis ad 2.5 m. longis, ramulis crassis subteretibus (juventute angulatis) demum cinereis; petiolis rugosis crassis 6–10 mm. longis; laminis coriaceis siccitate fuscis elliptico-oblongis, 6–9 cm. longis, 2–3 cm. latis, basi acutis vel attenuatis, apice cuspidatis (acumine ad 4 mm. longo obtuso), margine integris et saepe conspicue recurvatis, 5-pli-nerviis, nervis interioribus 1–2 cm. supra basim orientibus cum costa supra impressis subtus prominentibus, nervis exterioribus paullo debilioribus, venulis immersis; inflorescentiis e ramulis defoliatis orientibus breviter racemosis ut videtur 2–6-floris, rhachi gracili glabra ad 8 mm. longa, pedicellis gracilibus (apicem versus conspicue gradatim incrassatis) 9–11 mm. longis distaliter albo-puberulis, basi bracteis oblongis circiter 1.5 mm. longis subtentis, prope medium inconspicue bibracteolatis; calyce ubique extus pilis patentibus circiter 0.2 mm. longis persistenter albo-puberulo, tubo circiter 2 mm. longo et 3 mm. diametro, limbo erecto-patente circiter 2 mm. longo tenuiter carnoso, lobis 5 deltoideis acutis circiter 1 mm. longis et 2.5 mm. latis; corolla carnosa urceolata, 10–13 mm. longa, basim versus 4–6 mm. diametro, apicem versus ad 2–3 mm. diametro contracta, distaliter ut calyce albo-puberula, lobis 5 acutis circiter 0.7 mm. longis et 1.3 mm. latis; staminibus 10 alternatim circiter 4 mm. et 4.5 mm. longis, filamentis glabris in tubo membranaceo pallido circiter 2.5 mm. longo connatis, antheris alternatim circiter 2 mm. et 2.3 mm. longis, tubulis latis poris circiter 0.6 mm. longis dehiscentibus; stylo gracili corollam subaequante, stigmate minuto subpeltato.—Coclé: much-branched epiphytic shrub, the branches to 2.5 m. long, the flowers arising from old branchlets; pedicel and calyx coral-pink; corolla coral-pink, the distal

portion pure white; vicinity of La Mesa, north of El Valle de Antón, alt. 1000 m., April 12, 1941, *Allen 2367* (A, TYPE).

Satyria Allenii is closely related only to *S. meiantha* Donn. Sm. of Guatemala and British Honduras, from which it differs in its smaller leaf-blades with more highly connate secondary nerves and completely immersed veinlets, its persistently puberulent calyx, and its smaller anthers. The common Central American *S. Warszewiczii* Kl. differs from *S. Allenii* in its long pedicels, glabrous flowers, and much longer corollas and anthers. *Satyria ovata* A. C. Smith differs from the new species in its proportionately broader and obtuse leaf-blades, apparent veinlets, elongate corollas, etc.

DISTERIGMA HUMBOLDTII (Kl.) Nied. Bot. Jahrb. **11**: 224. 1889; A. C. Smith, Brittonia **1**: 222. 1933.—CHIRIQUÍ: epiphytic shrubs with pale pink flowers; vicinity of Bajo Chorro, alt. 1900 m., *Woodson & Schery 633* (NY), *684* (NY).

Although not otherwise reported from Panama, the species occurs in some abundance in the adjacent parts of Costa Rica and also in Colombia; it will doubtless be found in other parts of Panama.

THEOPHRASTACEAE

(C. L. Lundell, Ann Arbor, Mich.)

CLAVIJA **Alleni** Lundell, sp. nov. Arbor, ramulis crassis. Folia petiolata, petiolo ad 2 cm. longo, lamina glabra, subcoriacea, anguste cuneato-oblanceolata, 30–43 cm. longa, 6–7.5 cm. lata, apice acuta vel subacuminata, basi anguste cuneata, margine remote serrulata. Inflorescentiae ♂ pendulae, subpaucifloraे, ad 36 cm. longae, parce minute puberulae. Pedicelli ad 2 mm. longi. Flores 4-meri. Sepala basi coalita, suborbicularia, 1–1.2 mm. longa, fimbrillata. Corolla ca. 1 cm. diam., 6 mm. longa, aurantiaca, lobis suborbicularibus. Ovarium floris ♂ substipitiforme.

A tree, 10 m. tall, branchlets thick, about 1.2 cm. in diam., with the leaves crowded at the apex, obscurely and minutely furfuraceous. Petioles thick, up to 2 cm. long, the basal half drying blackish. Leaf blades glabrous, subcoriaceous, slightly paler beneath, narrowly cuneate-oblanceolate, 30–43 cm. long,

6–7.5 cm. wide, apex acute or subacuminate, base narrowly cuneate, decurrent, margin remotely serrulate, the teeth not over 1 mm. long, veinlets reticulate on both surfaces. Staminate racemes borne chiefly below the leaves on old wood, slender, pendulous, up to 36 cm. long, sparsely puberulent, with few scattered flowers. Bractlets minute, triangular, about 0.5 mm. long, minutely puberulent. Pedicels reflexed, minutely puberulent, up to 2 mm. long, usually about 1.4 mm. long. Flowers orange-colored, 4-merous. Sepals suborbicular, 1–1.2 mm. long, fimbrillate. Corolla about 1 cm. in diam., 6 mm. long, the basal third connate, the lobes suborbicular. Staminodia alternate with the petals, small. Stamens united into a tube, conglutinate, 8-dentate from above. Abortive ovary substipitiform.—CANAL ZONE: vicinity of Madden Dam, alt. 100 m., Aug. 1, 1941, *P. H. Allen 2671* (Herb. Missouri Bot. Gard., TYPE; Herb. Univ. Michigan, fragment of TYPE).

The narrowly cuneate-oblanceolate serrulate leaf blades, long pendulous puberulent staminate racemes, and short puberulent reflexed pedicels characterize the species. The other members of the genus known from Central America all have entire leaves.

MYRSINACEAE

(C. L. Lundell, Ann Arbor, Mich.)

ARDISIA **coclensis** Lundell, sp. nov. Arbor parva, ramulis crassis, furfuraceis. Folia petiolata, petiolo ad 1.5 cm. longo, lamina subcoriacea, integra, cuneato-oblanceolata vel elliptico-oblonga, 15–22 cm. longa, 5.6–8.2 cm. lata, apice acuta, basi cuneata. Inflorescentiae terminales, pyramidales, corymbosae, lepidotae. Pedicelli ad 1.8 cm. longi. Sepala 5, late ovata, 3–3.5 mm. longa, ciliata, punctata. Petala 5, lanceolato-oblonga, 10–11 mm. longa, acuta, reflexa. Stamina ca. 9 mm. longa.

A small tree, 3 m. high; branchlets thick, furfuraceous, the scales brownish, compact. Petioles stout, up to 1.5 cm. long. Leaves clustered at apex of branchlet, the blades pallid, subcoriaceous, entire, cuneate-oblanceolate or elliptic-oblong, 15–22 cm. long, 5.6–8.2 cm. wide, apex acute, base cuneate, decurrent, sparsely lepidote beneath, costa slightly impressed

above, prominent beneath, the primary lateral veins fine but evident on both surfaces, obscurely reticulate. Inflorescence brown-lepidote, terminal, pyramidal, weak with slender rachis and primary branches, 22 cm. long, 18 cm. wide, the flowers corymbose, comparatively few, large, rose-pink. Pedicels lepidote, slender, up to 1.8 cm. long. Sepals 5, free almost to base, broadly ovate, 3–3.5 mm. long, apex rounded and obliquely emarginate, lepidote and punctate, ciliate. Petals 5, cohering at base only, lanceolate-oblong, 10–11 mm. long, acute, inconspicuously punctate, reflexed at anthesis. Stamens about 9 mm. long; filaments united into a tube about 2 mm. long; anthers sessile, erect, lanceolate, acuminate, cohering at base. Ovary subglobose, glabrous; style equaling stamens.—COCLÉ: vicinity of El Valle de Antón, alt. about 600 m., *P. H. Allen 2056* (Herb. Univ. Michigan, TYPE).

A. coclensis, apparently referable to the subgenus Icacorea, has peculiar stamen characteristics somewhat suggestive of the subgenus Walleniopsis. The filaments coalesce into a tube and the erect sessile anthers adhere at base. The species may have affinity to *A. Pittieri* Mez, a plant known to the writer only from Standley's brief description (Field Mus. Publ. Bot. **18**: 893. 1938).

ARDISIA **geniculata** Lundell, sp. nov. Arbor parva, ramulis furfuraceis. Folia petiolata, petiolo 3–6 mm. longo, lamina membranacea, anguste elliptica vel oblanceolato-elliptica, 5.8–11 cm. longa, 2.5–4.3 cm. lata, apice subabrupte acuminata, acumine obtuso, basi attenuata, parce lepidota. Inflorescentiae geniculatae, terminales, lepidotae, subumbellatae. Pedicelli ad 10 mm. longi. Sepala 5, late ovata, 1 mm. longa, subintegra. Petala 5, lineari-oblonga, 5 mm. longa. Stamina 3.5 mm. longa.

A tree, 4 to 5 m. high; branchlets slender, furfuraceous, ferruginous. Petioles furfuraceous, canaliculate, 3–6 mm. long. Leaf blades membranaceous, paler beneath, narrowly elliptic or oblanceolate-elliptic, 5.8–11 cm. long, 2.5–4.3 cm. wide, apex subabruptly acuminate, the acumen obtusish, base attenuate, decurrent, sparsely lepidote, costa plane above, prominent beneath, primary veins 12–16 on each side, conspicuous beneath.

Inflorescence terminal, abruptly geniculate at base, lepidote, bipinnate, few-flowered, less than 4 cm. long, the flowers subumbellate, white. Pedicels slender, up to 10 mm. long. Sepals 5, broadly ovate, 1 mm. long, prominently punctate, the margin scarious, subentire, apex rounded, obscurely emarginate laterally. Petals 5, linear-oblong, slightly wider above middle, 5 mm. long, united (1 mm.) at base, acutish, orange-punctate. Stamens about 3.5 mm. long; filaments stout, less than 1 mm. long; anthers linear-lanceolate, concolorous, abruptly apiculate, dehiscent apically. Ovary glabrous; style slender, 4 mm. long.—CHIRIQUÍ: vicinity of San Bartolomé, Peninsula de Burica, alt. up to 5 m., July 28–Aug. 1, 1940, *Woodson & Schery 944* (Herb. Univ. Michigan, TYPE).

A. geniculata, referable to the subgenus Icacorea, is noteworthy for its geniculate inflorescence.

ARDISIA **rigidifolia** Lundell, sp. nov. Arbor parva, ramulis crassiusculis. Folia petiolata, petiolo crassiusculo, 3–5 mm. longo, lamina rigide coriacea, pallida, elliptica, 3.5–6.5 cm. longa, 2–3.2 cm. lata, apice obtusa, basi late cuneata. Inflorescentiae terminales, pyramidales, ad 7 cm. longae et latae, furfuraceae, umbellatae. Pedicelli 4–5 mm. longi. Sepala 5, ovata, 1–1.3 mm. longa, minute erosa. Petala 5, oblonga, 5 mm. longa, apice acutiuscula. Stamina ca. 3.5 mm. longa. Stylus 5.2 mm. longus.

A small tree, 2.5 m. high; buds and tips of branchlets dark reddish brown, furfuraceous; branchlets rather thick, gnarled, with very short internodes. Petioles stout, 3–5 mm. long. Leaves clustered at ends of branchlets, the blades rigidly coriaceous, pallid, paler on under surface, minutely punctate, elliptic, 3.5–6.5 cm. long, 2–3.2 cm. wide, apex obtuse or obtusely subacuminate, base broadly cuneate, decurrent, costa plane above, prominent beneath, primary veins slender, prominulous beneath. Inflorescence terminal, tripinnately paniculate, pyramidal, up to 7 cm. long and wide, furfuraceous, many-flowered, the flowers white, umbellate; bractlets up to 1 cm. long, lepidote. Pedicels 4–5 mm. long. Sepals 5, ovate, 1–1.3 mm. long, punctate with few conspicuous orange-red glands, the

margin scarious, minutely erose. Petals 5, oblong, 5 mm. long, apex acutish, asymmetrical, punctate with few inconspicuous glands. Stamens about 3.5 mm. long; filaments about 1 mm. long, thick; anthers lanceolate, concolorous, apically dehiscent, not apiculate. Ovary glabrous; style 5.2 mm. long.—COCLÉ: vicinity of El Valle, alt. 800–1000 m., Dec. 22, 1936, *P. H. Allen 71* (Herb. Univ. Michigan, TYPE).

A. rigidifolia is a none too well marked species related to *A. minor* Standl., and referable to the subgenus Icacorea. From *A. minor* it differs in having gnarled branchlets, small rigidly coriaceous leaves, comparatively large tripinnately paniculate furfuraceous inflorescences, smaller sepals, and a longer style.

ARDISIA **Scheryi** Lundell, sp. nov. Arbor glabra, ramulis crassiusculis. Folia petiolata, petiolo ad 8 mm. longo, lamina glabra, integra, coriacea, lanceolata vel lanceolato-elliptica, 4.5–7.5 cm. longa, 1.6–3.2 cm. lata, apice acuminata, basi acutiuscula. Inflorescentiae terminales, pyramidales, multiflorae, umbellatae. Pedicelli 2–3 mm. longi. Sepala fere 1 mm. longa, subintegra. Corolla glabra, 4 mm. longa. Stamina 3 mm. longa. Antherae latae, oblongo-ellipticae, apice rotundatae et minute emarginatae. Ovarium glabrum.

A tree, 20 m. high; branchlets reddish, rather stout, glabrous. Petioles narrowly winged, up to 8 mm. long. Leaf blades entire, glabrous, coriaceous, drying reddish-brown, paler beneath, lanceolate or lanceolate-elliptic, 4.5–7.5 cm. long, 1.6–3.2 cm. wide, apex attenuate, acuminate, base acutish, decurrent, primary veins conspicuous on both surfaces. Inflorescence terminal, pyramidal, up to 14.5 cm. long, 13.5 cm. wide, glabrous, reddish-brown; the flowers pale pink, numerous, umbellate. Pedicels slender, 2–3 mm. long, glabrous. Flower buds about 3 mm. long. Sepals scarcely 1 mm. long, ovate, subentire, scarious, prominently orange-punctate. Corolla 4 mm. long, the petals short connate at base, lanceolate-oblong, acutish, orange-punctate, glabrous. Stamens 3 mm. long; anthers oblong-elliptic, nearly twice as long as filaments, rounded and shallowly notched at apex. Ovary globose, glabrous.—CHIRI-

QUÍ: vicinity of Bajo Chorro, alt. 1900 m., July 20–22, 1940, *Woodson & Schery 686* (Herb. Univ. Michigan, TYPE).

A. Scheryi, which belongs to the subgenus Icacorea, is allied to *A. multiflora* Griseb. and *A. pallidiflora* Standl. From the two, *A. Scheryi* may be recognized immediately by its short pedicels. The tree is remarkably large for the genus.

ARDISIA SEIBERTII Standl., Ann. Missouri Bot. Gard. **24**: 198. 1937.—COCLÉ: flowers white; El Valle de Antón and vicinity, alt. 500–700 m., July 23–27, 1935, *R. J. Seibert 456* (Herb. Field Mus., TYPE); a small tree, 3 m. high, fleshy calyx pink; vicinity of El Valle, alt. 800–1000 m., Dec. 22, 1936, *P. H. Allen 72;* a small tree, 2 m., flowers pale pink; vicinity of El Valle, alt. 800–1000 m., Sept. 5, 1938, *Allen 786;* a tree, 8 m. high, calyx and pedicels white, corolla pink; between Las Margaritas and El Valle, July 15–Aug. 8, 1938, *R. E. Woodson, Jr., P. H. Allen & R. J. Seibert 1239;* a shrub, 3 m. high, petals white, faint lavender-tinged; same locality and date, *Woodson, Allen & Seibert 1746;* a small tree, 4 m. high, flowers pale lavender; north rim of El Valle, June 4, 1939, *P. H. Allen & A. H. G. Alston 1846;* PANAMÁ: a small tree, 3 m. high, flowers pink; summit of Cerro Campana, alt. 800–1000 m., Sept. 1, 1940, *Allen 2226.*

A. Seibertii is very close to *A. opegrapha* Oerst. of the subgenus Graphardisia. *A. opegrapha* has larger narrower oblanceolate rather than elliptic or oblanceolate-elliptic leaves, somewhat less ample inflorescences, shorter fruiting pedicels, and narrower smaller sepals. These are differences of perhaps minor importance.

For the loan of the type of *A. Seibertii,* an isotype of *A. opegrapha,* and other material of these in the Field Museum Herbarium the writer is indebted to the Director, Mr. C. C. Gregg.

ARDISIA **Woodsoni** Lundell, sp. nov. Arbor parva. Folia petiolata, petiolo crassiusculo, ad 6 mm. longo, lamina coriacea, integra, 5–7.5 cm. longa, 1.7–2.8 cm. lata, apice obtusa, basi late cuneata. Inflorescentiae terminales, ca. 5 cm. longae, glabrae, subcorymbosae. Pedicelli 1–1.3 cm. longi. Sepala 5,

late ovata, ca. 2 mm. longa, subintegra. Bacca globosa, 6 mm. diam.

A tree, 8 m. high, buds and tips of branchlets furfuraceous, glabrous otherwise; branchlets slender, terete and brown. Petioles comparatively stout, marginate to base, up to 6 mm. long. Leaf blades coriaceous, paler beneath, entire, 5–7.5 cm. long, 1.7–2.8 cm. wide, apex narrowed to an obtuse point, base broadly cuneate, decurrent, costa plane above, slightly elevated on lower surface, primary veins slender, evident but not conspicuous. Inflorescence terminal, about 5 cm. long, few-flowered, the flowers subcorymbose. Pedicels slender, 1–1.3 cm. long, slightly curved. Sepals 5, broadly ovate, about 2 mm. long, rounded at apex, punctate with conspicuous orange-red dots, the margin scarious, minutely erose, essentially entire. Berries globose, 6 mm. in diam., black-purple when ripe.—CHIRIQUÍ: vicinity of Finca Lérida, alt. 1750 m., July 7–11, 1940, *Woodson & Schery 230* (Herb. Univ. Michigan, TYPE).

A. Woodsoni belongs to the subgenus Icacorea where its nearest relative appears to be *A. minor* Standl. *A. minor* is described as having stout pedicels 2–5 mm. long, while the pedicels of *A. Woodsoni* are slender and usually exceed 1 cm. in length.

PARATHESIS **Woodsoni** Lundell, sp. nov. Arbor, ramulis furfuraceis. Folia petiolata, petiolo 7–12 mm. longo, lamina chartacea, oblanceolata, 5–9 cm. longa, 1.5–2.6 cm. lata, apice acuminata, acumine obtusiusculo, basi acuta, subintegra, supra glabra, subtus parce lepidota. Inflorescentiae axillares, ad 12 cm. longae, parce lepidotae. Pedicelli 7–11 mm. longi. Sepala 5, anguste triangularia, 1–1.2 mm. longa, punctata. Petala 5, extus puberula, intus tomentosa, punctata, lanceolato-attenuata, 6 mm. longa. Stamina 3–3.5 mm. longa, filamentis glabris, antheris ca. 2.3 mm. longis, haud punctatis. Ovarium ad apicem tomentellum; stylus basi tomentellus. Bacca depresso-globosa.

A tree; branchlets furfuraceous, ferruginous, rather slender, with short internodes and conspicuous leaf scars. Petioles furfuraceous, canaliculate, 7–12 mm. long. Leaf blades thinly

chartaceous, oblanceolate, 5–9 cm. long, 1.5–2.6 cm. wide, apex short-acuminate, the acumen obtusish, base acute, slightly decurrent, margin somewhat repand, essentially entire, rather sparsely lepidote beneath, minutely but conspicuously black-punctate, costa slightly impressed above, prominent beneath, the primary veins slender, 11–14 on each side, prominulous. Inflorescence axillary, up to 12 cm. long, with long slender peduncle, sparsely lepidote, ferruginous. Pedicels slender, 7–11 mm. long. Sepals puberulent, punctate, narrowly triangular, 1–1.2 mm. long. Corolla pink, the petals puberulent outside, tomentose within, conspicuously linear-punctate, lanceolate-attenuate, widest at base, 6 mm. long. Stamens 3–3.5 mm. long; filaments glabrous, subequaling anthers; anthers about 2.3 mm. long, base sagittate, attenuate to an acutish apex, concolorous, not punctate. Apical half of ovary and base of style tomentellous, the style about 5 mm. long, linear-punctate. Berries deep purple, depressed-globose, about 7 mm. in diam.—CHIRIQUÍ: Finca Lérida to Peña Blanca, 1750–2000 m., July 9, 1940, *Woodson & Schery 331* (Herb. Univ. Michigan, TYPE).

P. Woodsoni, closely allied to *P. Seibertii* Lundell, differs in its smaller leaves, considerably longer pedicels, larger flowers, and concolorous anthers. The anthers are not punctate, and this is probably the most distinctive characteristic of the plant.

GENTIANACEAE

(Caroline K. Allen, Jamaica Plain, Mass.)

HALENIA **euryphylla,** n. sp. Herba perennis (?), caule simplici ramoso procumbente, inferiori reliquiis foliorum instructo, ad 50 cm. alto, paullo alato; internodiis inferioribus ad 2 cm., superioribus ad 7 cm. longis; foliis sessilibus, superioribus caulinis basi petiolum 0.5–1.5 cm. longum foliaceum simulantibus, longe attenuatis, lamina elliptica conspicue apiculata, 3-nerviis, nervio medio prominente, ad 7.5 cm. longis et 2.7 cm. latis; inflorescentia terminali raro axillari cymosa aliquid laxa et pauciflora, ad 6.5 cm. longa; calyce ad 1 cm. longo et corollae longitudinem ca. ¾ aequante; lobis 3-nerviis oblanceolatis longe apiculatis minute papillosis; corolla (calcaribus in-

clusis) ad 1.5 cm. longa, ad 1 cm. lata, viridescenti-flava (fide collectoris), tubo totae corollae longitudinem ⅓ vel minus aequante; corollae lobis ellipticis, margine eroso; calcaribus corollae longitudinem fere aequantibus divaricatis leviter pendulis; capsula ovata ad 17 cm. longa, stylo apice longe apiculato; seminibus ellipsoideis 1.25 mm. longis.—CHIRIQUÍ: Casita Alta to Cerro Copete, ca. 2300–3300 m., July 10, 1940, *Woodson & Schery 362* (Gray Herb., TYPE, Herb. Missouri Bot. Gard., ISOTYPE).

The foliose stem and the general habit of this new species recall the widespread North American species *H. deflexa*. Actually *H. euryphylla* can claim close relationship with *H. guatemalensis* Loesener, but differs in its broad leaves, looser inflorescence and its flowers with divaricate, slightly pendulous, scarcely incurved spurs.

(J. A. Steyermark, Chicago)

VOYRIA **Allenii** Steyermark, sp. nov. Caulis crassiusculus 9–13 cm. altus, internodiis superioribus 4–5 mm. longis, inferioribus 13–17 mm. longis; flores vulgo solitarii et ramos terminantes, pedunculis 5–9 mm. longis; calycis tubus campanulatus 4.5–5 mm. longus, lobis 5 late ovatis obtusis minute ciliolatis 1.5–3 mm. longis; corolla lacte rosea hypocrateriformis extus ubique minute puberula, 3.5–4 cm. longa, lobis elliptico-ovatis obtusis 1.4–1.5 cm. longis 0.8–0.9 cm. latis; filamenta brevissima, antheris subgloboso-rhomboideis 1.2–1.3 mm. longis; stylus gracilis 2.7 cm. longus.

Stem stout, 9–13 cm. high, 2–2.5 mm. thick, once-branched in the upper half; scales opposite, dull red, those on the upper floriferous stems 4–5 mm. apart, the ones in the lower portion of the stems 13–17 mm. apart, broadly ovate, 4–5 mm. long, 3–4 mm. broad, the sinus subacute, obtuse to rounded, minutely ciliolate, connate in lower half to third, glabrous; usually a solitary bright pink flower terminating each branch of the stem; peduncles 5–9 mm. long, stout; calyx-tube campanulate, 4.5–5 mm. long, 3–6 mm. wide at the throat, lobes 5, minutely ciliolate, broadly ovate, obtuse, 1.5–3 mm. long, 1.5–3 mm. broad

at the base, subequal; corolla bright pink, large and showy, hypocrateriform, broadened at the base around the ovary and slightly constricted in the upper portion below the insertion of the stamens, minutely puberulous over the entire outer surface, 3.5–4 cm. long, broadened to 5–6 mm. around the ovary, slightly narrower in upper half, lobes elliptic-ovate, obtuse, the margins round-curved and narrowed at the base, 1.4–1.5 cm. long, 0.8–0.9 cm. broad, minutely papillate without, minutely ciliolate; filaments inserted in the upper half of the tube 6–7 mm. below the throat, very short, 0.5 mm. long; anthers subglobose-rhomboid, 1.2–1.3 mm. long; style slender, 2.7 cm. long, glabrous; stigma dome-shaped, sinuate-peltate; ovary glabrous, ellipsoid, 8–9 mm. long, in fruit 1.5 cm. long, 5 mm. in diameter.—COCLÉ: hills north of El Valle de Antón, alt. 800 m., Sept. 8, 1940, *Allen 2240* (Herb. Field Mus., TYPE).

The genus *Voyria,* as delimited by Aublet and excluding species of *Leiphaimos* which have sometimes been merged with it, comprises a few rare and local species confined to Colombia and British Guiana. The genus has not hitherto been reported for Central America. *Voyria Allenii* is most closely related to *V. macrantha* Killip[1] described from Colombia, from which it differs in its shorter calyx-tube, shorter corolla-lobes, pink instead of red-purple corolla and corolla-tube puberulent throughout on the outside. From *V. rhodochroa* Sandwith,[2] it differs in the flowers borne solitary and terminal on the one or two branches, not fasciculate-corymbose, and in the larger corolla-lobes. From *V. rosea* Aubl. it differs in its obtuse calyx- and corolla-lobes and solitary terminally borne flowers, while from *V. caerulea* Aubl. it differs in its scales and calyx-lobes rounded and not acute, in its pink instead of blue or violet corollas, and fewer-branched stems.

APOCYNACEAE

STEMMADENIA **Allenii** Woodson, spec. nov. Arbuscula ca. 3 m. alta; ramulis gracilibus dichotome compositis omnino glabris. Folia opposita elliptica apice acute subcaudato-

[1] Journ. Wash. Acad. Sci. **26**: 361. 1936. [2] Kew Bull. **1931**: 55. 1931.

acuminata basi in petiolo brevissimo ca. 0.5 cm. longo gradatim attenuata petiolo incluso 6–15 cm. longa 2.0–5.5 cm. lata membranacea glabra. Inflorescentia 1–4-flora; pedunculo ca. 1 cm. longo; pedicellis ca. 0.5 cm. longis omnino glabris. Calycis lobi oblongi obtusi 0.6–0.9 cm. longi subfoliacei glabri. Corolla "fere alba, centro dilute flava"; tubo proprio ca. 1.25 cm. longo basi ca. 0.3 cm. diam. apicem versus attenuato ibique et staminigero et sinistrorse contorto; faucibus conicis ca. 2 cm. longis ostio ca. 1 cm. diam.; lobis oblique obovatis ca. 1.5 cm. longis patulis. Folliculi anguste gibbosi angustissime attenuati ca. 3.5 cm. longi medio ca. 0.7 cm. crassi.—COCLÉ: hills north of El Valle de Antón, alt. ca. 1000 m., July 14, 1940, *P. H. Allen 2187* (Herb. Missouri Bot. Gard., TYPE); same locality, alt. 800 m., Sept. 8, 1940, *Allen 2239* (Herb. Missouri Bot. Gard., CO-TYPE).

At first glance, this species was mistaken for *S. Alfari* (Donn. Sm.) Woodson, which, however, has much smaller calyx lobes, and smaller corollas with narrower throat and shorter lobes. Mr. Allen has taken considerable interest in this species, and finds it to be fairly abundant in the neighborhood of the type locality.

ASCLEPIADACEAE

GONOLOBUS **chiriquensis** Woodson, comb. nov. *(Vincetoxicum chiriquense* Woodson, in Woodson & Seibert, Ann. Missouri Bot. Gard. **24**: 199. 1937).

This combination will be made necessary by the impending conservation of *Vincetoxicum* Moench over *Vincetoxicum* Walt. (see Perry, Rhodora **40**: 281–282. 1938).

GONOLOBUS **fuscoviolaceus** Woodson, spec. nov. Frutex volubilis; ramulis gracilibus glabris, internodiis 7–12 cm. longis. Folia petiolata ovato-oblonga basi late rotundata fere cordata apice subcaudato-acuminata 4.5–11.0 cm. longa 1.5–4.5 cm. lata firme membranacea glabra subtus pallidiora, petiolo 1.5–2.5 cm. longo. Inflorescentia bostrycino-umbellata pluriflora; pedunculo ca. 1 cm. longo glabro; pedicellis ca. 0.5 cm. longis glabris; bracteis vix manifestis. Flores viridi-fusci; calycis

laciniis ovato-oblongis acutis glabris 0.25 cm. longis; corolla rotata ca. 0.9 cm. diam. faucibus minute pilosulis caeterumque glabra, lobis late ovatis obtusis minute emarginatis patulis; gynostegio subsessili ca. 0.15 cm. diam., stigmate depresso, polliniis cochleariformibus caudiculis inclusis ca. 0.05 cm. longis; corona rotata margine leviter crenulata gynostegium vix aequante. Folliculi immaturi fusiformes laeves glabri.—CHIRIQUÍ: vicinity of Bajo Chorro, alt. 1900 m., July 20–22, 1940, *Woodson & Schery 695* (Herb. Missouri Bot. Gard., TYPE). Most closely related to the preceding, but differing in the conspicuously smaller leaves and flowers. These two species differ from those of typical *Gonolobus* in the fact that the anthers are placed about the margin of the stigma head and not beneath it, together with other rather slight characters which probably should be viewed as subgeneric rather than as generic. Similar characters have not been found to be generic in other Gonolobeae.

CONVOLVULACEAE

IPOMOEA DEMERARIANA Choisy (determination from herbarium comparisons, but type not available). Probably the same as *Ipomoea cardiosepala* Meisn. of Colombia, a later name published in Mart. Fl. Bras. Also specimens of this species can be found in herbaria evidently incorrectly labeled as *Ipomoea phillomega* (Vell.) House.—BOCAS DEL TORO: vicinity of Isla Colon, alt. 0–120 m., Aug. 23, 1940, *H. von Wedel 514*. Previously known from South America and the West Indies.

IPOMOEA **mucronata** Schery, spec. nov. Suffrutex volubilis in fruticibus; caulibus, pedunculis petiolisque summe pubescentibus; laminis foliorum integris, lanceolatis, profunde cordatis, 4–9 cm. longis, prope basim 4–9 cm. latis, utrinque pubescentibus praesertim in venulis, petiolis quam laminis longioribus, 4–14 cm. longis; pedunculis quam petiolis longioribus, 10–25 cm. longis; inflorescentiis subcorymbiformibus, floribus multis vel paucis, terminalibus 3.5–4.5 cm. longis, puniceo-purpureis, pedicellis pubescentibus floribus brevioribus (plerumque ca. 1 cm. longis); sepalis subaequalibus,

pilosis, oblongo-ellipticis, apice subulatis vel mucronatis, coriaceis, 7–11 mm. longis, 2–4 mm. latis; stylis persistentibus; capsulis dehiscentibus, bicubiculis, apice leviter pilosis; seminibus glabris, suborbicularibus, ca. 4 mm. diametro cum locis figitis orbicularibus.—PANAMA: CHIRIQUÍ: near Peña Blanca, alt. 1750–2000 m., July 9, 1940, *Woodson & Schery 283, 323* (Herb. Missouri Bot. Gard., TYPE); COSTA RICA: SAN JOSÉ: vicinity of El General, alt. 850 m., Feb. 1936, *A. F. Skutch 2570.*

This species is close to *I. trichocarpa* Ell. and *I. longipes* Garcke, but differs chiefly in having dense pubescence, lavender or rose flowers and pilose sepals. The outer mucronate sepals are slightly smaller than the inner ones. The 2-celled capsule dehisces longitudinally, usually into three parts. In the specimen examined, only one seed developed in each capsule. The seed has a circular, raised, tire-like area at the point of attachment.

VERBENACEAE

(H. N. Moldenke, New York)

CITHAREXYLUM HIRTELLUM Standl.—CHIRIQUÍ: vicinity of Boquete, alt. 1200–1500 m., July 24–26, 1940, *Woodson & Schery 755.*

LABIATAE

(C. C. Epling, Los Angeles)

SALVIA IRAZUENSIS Fern.—CHIRIQUÍ: Potrero Muleto, Volcan de Chiriquí, alt. 10500 m., July 13, 1940, *Woodson & Schery 386.* Previously considered to be an endemic of Costa Rica.

SOLANACEAE

(C. V. Morton, Washington, D. C.)

SOLANUM SEAFORTHIANUM Andrews.—CHIRIQUÍ: vicinity of Finca Lérida, alt. 1750 m., July 7, 1940, *Woodson & Schery 239.* New to Panama. Probably escaped from cultivation.

SOLANUM QUINQUANGULARE Willd.—CHIRIQUÍ: Finca Lérida to Peña Blanca, alt. 1750–2000 m., July 9, 1940, *Woodson & Schery 290.* Previously known from northern South America.

SOLANUM ROBLENSE Bitt.—CHIRIQUÍ: vicinity of Callejon Seco, Volcan de Chiriquí, alt. 1700 m., July 17, 1940, *Woodson & Schery 487.* Previously known from Costa Rica.

Solanum evolvulifolium Greenm.—chiriquí: vicinity of Bajo Chorro, alt. 1900 m., July 20, 1940, *Woodson & Schery 649*. Previously known from Costa Rica.

GESNERIACEAE
(C. V. Morton, Washington, D. C.)

Drymonia alloplectoides Hanst.—coclé: north rim of El Valle de Antón, near Cerro Turega, alt. 650–700 m., June 30, 1940, *Woodson & Schery 162*. New to Panama. Previously known from Costa Rica.

Alloplectus ichthyoduma var. pallidus Morton.—chiriquí: Casita Alta to Cerro Copete, Volcan de Chiriquí, alt. 2300–3300 m., July 10, 1940, *Woodson & Schery 359*. Previously known from Costa Rica.

Columnea consanguinea Hanst.—chiriquí: vicinity of Bajo Chorro, alt. 1900 m., July 20, 1940, *Woodson & Schery 651*. Previously known from Costa Rica.

Campanea Humboldtii (Kl.) Oerst.—chiriquí: vicinity of Bajo Chorro, alt. 1900 m., July 20, 1940, *Woodson & Schery 656*. Previously known from Costa Rica.

Besleria pycnosuzygia Donn. Sm.—chiriquí: vicinity of Bajo Chorro, alt. 1900 m., July 21, 1940, *Woodson & Schery 683*. Previously known from Costa Rica.

Achimenes candida Lindl.—chiriquí: llanos, vicinity of Boquete, alt. 1200–1500 m., July 26, 1940, *Woodson & Schery 764*. Previously known from Guatemala and Costa Rica.

ACANTHACEAE
(E. C. Leonard, Washington)

Glockeria **reflexiflora** Leonard, sp. nov. (fig. 1). Herba epiphytica, caulibus subteretibus glabris vel ad nodos puberulis; lamina foliorum oblonga vel oblongo-lanceolata, acuminata, basi angustata, membranacea, undulata, glabra, in costa et venis parce strigosa; petioli breves; panicula grandis, puberula, ramis tenuibus; bracteae subulatae; pedicelli reflexi; calyx glaber, segmentis anguste triangulatis; corolla glabra, aurantiaca, curvata, bilabiata, labio superiore oblongo apice minute

bidentato et serrato, inferiore trilobo, lobis brevibus, latis; stamina exserta; ovarium glabrum.

An epiphytic herb up to 1 meter high; stems subterete, glabrous or puberulent at the nodes; leaf blades oblong or oblong-lanceolate (one leaf of the uppermost pair excepted, this ovate,

Fig. 1. *Glockeria reflexiflora* Leonard: *a*, pair of leaves subtending the panicle to show asymmetry; *b*, portion of panicle; *c*, calyx; *d*, corolla; *e*, upper lip; *f*, lower lip (*a*, *b*, half natural size; *c*, *d*, *e*, *f*, twice natural size.)

subsessile, cordate at base), up to 13 cm. long and 4.5 cm. wide, acuminate (the tip blunt), narrowed at base, thin, undulate, glabrous, or the costa and lateral veins (6 or 7 pairs) sparingly strigillose; petioles up to 5 mm. long; flowers numerous, reflexed, borne in a puberulent terminal panicle 30 cm. long and about 10 cm. in diameter, the ultimate branches very slender;

bracts subulate, up to 3 mm. long; pedicels slender, 2 to 3 mm. long, reflexed; calyx 4 mm. long, glabrous, the segments narrowly triangular, 3 mm. long and 0.5 mm. wide at base, the tips blunt; corolla about 2 cm. long, orange, glabrous, slightly curved, 1 mm. in diameter at base, enlarged from the tip of the calyx to a tubular throat about 4 mm. in diameter, the upper lip erect, oblong, 5 mm. long, 3 mm. wide, rounded, minutely bidentate and serrate at tip, the lower lip short, truncate, with 3 low broad lobes; stamens exserted, the filaments flat, glabrous; ovary glabrous; capsule not seen.—CHIRIQUÍ: vicinity of Bajo Mona and Quebrada Chiquero, alt. 1500 m., July 18, 1940, *R. E. Woodson, Jr. & R. W. Schery 547* (U. S. Nat. Herb. No. 1,791,983, TYPE).

This species is easily recognized by its large puberulous panicle of reflexed orange flowers.

DICLIPTERA **gracilis** Leonard, sp. nov. (fig. 2). Herba, caulibus breviter striatis, glabris vel ad nodos tomentulosis; lamina foliorum lanceolato-ovata, acuta vel acuminata, basi rotundata, membranacea, integra, glabra, costa et venis obscure strigosis; petioli graciles; cymae tripartitae; pedunculi axillares graciles; bracteae capituli inaequales, coriaceae, ciliatae, intus puberulae, extus glabrae vel costa parce strigosa, bractea posterior linearis, obtusa, anterior lanceolata, apice rotundata; bracteolae lanceolatae, acutae, ciliatae, minute pubescentes; calycis segmenta anguste triangulata, minute pubescentia, leviter striata; corolla incarnata, pubescens, bilabiata, labio superiore acuminato, inferiore trilobo, lobis rotundatis; ovarium glabrum.

Herbaceous; stems up to 30 cm. high or more, ascending, 2 mm. in diameter or less, faintly striate, glabrous, or puberulous at the nodes; leaf blades lance-ovate, up to 3.5 cm. long and 1.6 cm. wide, acuminate at apex (the tip blunt), rounded at base and slightly decurrent on the petiole, thin, entire, glabrous except the costa and lateral veins (6 pairs), these inconspicuously and minutely strigose, more densely so above than beneath, sparingly ciliate, the cystoliths minute; petioles slender, up to 5 mm. long; cymes of 3 capitula on slender peduncles up to

5 cm. long, glabrous; pedicels 1 to 3 mm. long; bracts subtending the cymes similar to the leaves but smaller, those subtending the capitula unequal, firm, ciliate, the inner surface appressed-puberulent, the outer surface glabrous or the costa sparingly strigose, the larger bract linear, 13 mm. long, 2.5

Fig. 2. *Dicliptera gracilis* Leonard: *a*, portion of plant, natural size; *b*, calyx, spread to show segments; *c* and *d*, bracts; *e*, bractlet (*b*, *c*, *d*, *e*, twice natural size).

mm. wide near tip and base, 2 mm. wide at middle, obtuse, 3-nerved, the lateral nerves inconspicuous, the margins subhyaline near the base, the smaller bract of the pair lanceolate, 7 mm. long, 2.5 mm. wide at base, rounded at apex, 1-nerved, the margins subhyaline; bractlets lanceolate, 5.5 mm. long, 1.5 mm. wide at middle, acute, 1-nerved, finely pubescent toward the tip, ciliate; calyx 7 mm. long, finely pubescent toward tip, ciliate, the hairs of the inner surface appressed, the segments narrowly triangular, 4 mm. long, 1 mm. wide at base, gradually narrowed to a slender tip, faintly striate-nerved; corolla 3 cm. long, bright pink, pubescent (except the lower portion), 2.5 mm. in diameter at base, narrowed to 1.5 mm. at tip of calyx, thence enlarged to about 7 mm. and narrowed again to 4 mm. at mouth, the posterior lip 8 mm. long, acuminate, the lower lip about 5 mm. long, with 3 rounded lobes; ovary glabrous; capsule not seen.—CHIRIQUÍ: vicinity of Bajo Mona and Quebrada Chiquero, alt. 1500 m., July 18, 1940, *R. E. Woodson, Jr. & R. W. Schery 569* (Herb. Missouri Bot. Gard., TYPE).

Related to *D. trifurca* Oerst., but easily distinguished from that by its small thin leaf blades with rounded bases and by the much smaller bracts.

CUCURBITACEAE

FRANTZIA PITTIERI (Cogn.) Pittier—BOCAS DEL TORO: Nievecita, alt. 100 m., Aug. 3–20, 1940, *Woodson & Schery 1062*. Previously known from Costa Rica.

FEVILLEA CORDIFOLIA L.—CHIRIQUÍ: vicinity of San Bartolomé, Peninsula de Burica, alt. 0–50 m., July 28–Aug. 1, 1940, *Woodson & Schery 872*. Previously reported from Costa Rica and evidently widely distributed in tropical America. Also known from the West Indies and South America.

RUBIACEAE

(P. C. Standley, Chicago)

CEPHAELIS **chiriquensis** Standl., sp. nov. Frutex metralis omnino glaber, ramis crassiusculis teretibus, internodiis superioribus 3–7.5 cm. longis; stipulae ca. 1 cm. longae vel paullo breviores crassae fere ad basin bilobae, lobis approximatis late

oblongis apice anguste rotundatis erectis; folia longiuscule petiolata chartacea, petiolo gracili 2.5–3 cm. longo; lamina elliptico-ovalis 9–14.5 cm. longa 4.5–7 cm. lata, apice abrupte breviter acuminata, acumine anguste triangulari, basi acuta, concolor, costa gracili subtus bene elevata, nervis lateralibus utroque latere ca. 20 teneris prominentibus arcuatis regularibus et parallelis, venulis fere obsoletis; inflorescentia terminalis sessilis e capitulis 3 breviter pedunculatis composita, pedunculis crassissimis 7–10 mm. longis; capitula inaequalia, lateralibus paullo minoribus, centrali fere 2 cm. alta et aequilata; bracteae exteriores coriaceae fere 2 cm. longae late ovatae acutae vel acuminatae, interioribus paullo brevioribus ovatis vel oblongo-ovatis, intimis lanceolatis vel lineari-lanceolatis; flores bene evoluti non visi.—CHIRIQUÍ: vicinity of Bajo Chorro, alt. 1900 m., July 20–22, 1940, *Woodson & Schery 610* (Herb. Field Mus., TYPE).

The bracts are said to be purple. The species is not especially close to any other known from Panama or elsewhere in Central America. The inflorescence is distinctive, consisting of three large, terminal, short-pedunculate heads.

FARAMEA **Woodsonii** Standl., sp. nov. Frutex 1–2-metralis omnino glaber, ramis gracillimis teretibus viridibus, internodiis plerumque brevibus; stipulae 6–7 mm. longae virides breviter connatae sublaxae et non adpressae, basi late ovatae, sensim in setam rigidam attenuatae, persistentes; folia inter minora breviter petiolata laete viridia firme crasseque membranacea, petiolo crassiusculo 3–4 mm. tantum longo; lamina ovali-elliptica vel elliptico-oblonga 5–7.5 cm. longa 1.5–3 cm. lata subito breviter acuminata, basi acuta vel subacuta, supra sublucida, costa tenera prominente, subtus paullo pallidior, costa prominente, nervis lateralibus utroque latere ca. 8 tenerrimis vix elevatis angulo lato fere recto abeuntibus remote a margine laxe junctis, venulis fere obsoletis; inflorescentia terminalis umbelliformis pauciflora erecta 1.5–2 cm. longe pedunculata, basi foliis 2 lanceolato-oblongis viridibus acuminatis 1.5–2.5 cm. longis bracteiformibus fulcrata; pedicelli graciles sed rigidi usque 8 mm. longi inaequales; hypanthium

1.2 mm. altum late obovoideum in sicco cyaneum, calyce vix 0.6 mm. longo remote denticulato, disco crasso calyce fere duplo longiore; corolla caerulea, tubo ca. 8 mm. longo sursum paullo dilatato et vix ultra 2 mm. lato, lobis 4 ut videtur patentibus lineari-lanceolatis longe sensim attenuatis ca. 14 mm. longis; antherae inclusae; stylus gracilis 3 mm. longus.—COCLÉ: north rim of El Valle de Antón, near Cerro Turega, alt. 650–700 m., June 30, 1940, *Woodson & Schery 164* (Herb. Field Mus., TYPE).

Not easily confused with any other Central American species, being well marked by the small umbels of blue flowers, each umbel subtended by two green, bract-like leaves. The general appearance of the plant somewhat suggests that of some species of *Cestrum,* a resemblance observable also in other species of *Faramea,* particularly certain South American ones.

HOFFMANIA AREOLATA Standl.—CHIRIQUÍ: vicinity of Bajo Chorro, alt. 1900 m., July, 1940, *Woodson & Schery 661.* A small shrub with yellow flowers. Known previously only from the type, which was obtained in the same region.

HOFFMANIA DAVIDSONIAE Standl.—Known previously only from the type, *Davidson 216,* from Bajo Chorro, Boquete District, Provincia de Chiriquí, at 1800 meters. An additional collection has been made recently: CHIRIQUÍ: vicinity of Bajo Mona and Quebrada Chiquero, alt. 1500 m., July, 1940, *Woodson & Schery 595.* The flowers are described as brownish-yellow; Mrs. Davidson described them as pale pink. Well-developed corollas, not described when the species was published, are present with the later collection. The corolla is glabrous outside, 5 to 6 mm. long, with a very short tube, scarcely one-third as long as the lobes.

HOFFMANNIA **Woodsonii** Standl., sp. nov. Frutex vel arbuscula 2–4-metralis omnino glabra ramosa, ramis subteretibus sordide in sicco brunneis gracilibus, internodiis brevibus; stipulae parvae latissime triangulares acutiusculae; folia inter minora opposita graciliter petiolata membranacea, petiolo 1–2.2 cm. longo; lamina lanceolata usque oblongo-lanceolata, anguste elliptico-lanceolata, vel interdum lanceolato-ovata,

vulgo prope medium latissima, concolor, longe angusteque acuminata, basi cuneato-attenuata et decurrens, costa tenui vix subtus elevata, nervis lateralibus utroque latere 6–7 tenerrimis leviter arcuatis angulo semirecto adscendentibus; flores axillares brevissime racemosi, racemis paucifloris petiolo vulgo paullo brevioribus brevissime pedunculatis, pedicellis gracilibus vix ad 3 mm. longis; hypanthium turbinatum in sicco angulatum 2 mm. longum basi angustatum, lobis 4, ca. 0.6 mm. longis latissime ovato-triangularibus acutiusculis; corolla lutea in alabastro acutiuscula 4–5 mm. longa, tubo crasso, lobis subpatentibus oblongis acutiusculis tubo bene longioribus; antherae lobis corollae paullo breviores; bacca ut videtur fere matura late oblongo-obovoidea vix ultra 2.5 mm. longa.—CHIRIQUÍ: vicinity of Callejón Seco, Volcán de Chiriquí, alt. 1700 m., July 17, 1940, *Woodson & Schery 503* (Herb. Field Mus., TYPE); Quebrada Velo, alt. 1800 m., July 8, 1940, *Woodson & Schery 260.*

In the key to species of *Hoffmannia* in 'North American Flora,' the present plant would run either to *H. chiapensis* Standl., a species of Guatemala and southern Mexico, with which it has no close relationship, or to *H. Pittieri* Standl., of the Volcán de Chiriquí, Panama. It is related to the latter, which, however, is larger in all parts and has a much more ample inflorescence, often copiously branched and always with more numerous flowers.

COMPOSITAE

(S. F. Blake, Washington, D. C.)

ARCHIBACCHARIS **panamensis** Blake, sp. nov. Herba prope apicem ramosa 1.5 m. alta; caulis dense et sordide pilosiusculus; folia oblongo-elliptica v. elliptico-obovata brevissime petiolata acuta basi cuneata tenuia remote calloso-denticulata penninervia supra puberula subtus densius pilosiuscula; capitula feminea numerosa laxe cymoso-paniculata 5 mm. alta 20–21-flora, floribus hermaph. 1–2; phyllaria anguste linearia acuminata dorso puberula; corollae fem. ligulatae, ligula erecta 1 mm. alta ramis styli breviore; corollae hermaph. usque ad apicem tubae 5-partitae.

"Tall herb, 1.5 m. high;" stem simple below the inflorescence, bearing branches in the upper axils, subterete, somewhat striate, pithy, 3 mm. thick, straight, densely pilosiusculous with more or less crisped, many-celled, brownish hairs about 0.2 mm. long, not glandular; petioles broad, naked, sordid-puberulous, 1–1.5 mm. long; blades 7–9 cm. long, 2.3–3 cm. wide, callous-apiculate (apiculus 1 mm. long), remotely denticulate above the entire lower ⅖ of their length (teeth 5–8 pairs, slender, callous-tipped, about 0.5 mm. high, 4–11 mm. apart), above dark dull green, evenly puberulous on surface and veins with several-celled spreading hairs, more densely so on costa, beneath somewhat grayish-green, rather densely spreading-short-pilose with lax several-celled hairs (0.2–0.4 mm. long), more densely so along costa and veins, feather-veined (the principal veins about 6 pairs, prominulous beneath, the veinlets translucent, not prominulous, the costa prominent and whitish at base); leaves of the branches smaller; individual panicles terminal and in the upper axils, loose, many-headed, pubescent like the stem, on peduncles 6 cm. long or less, 1.5–6 cm. wide, together forming a large leafy panicle, the pedicels mostly 6–10 mm. long, filiform, naked or with a filiform-subulate bract; involucre about 4-seriate, graduated, 4–5 mm. high, the phyllaries narrowly linear or the outer linear-subulate, 0.2–0.5 mm. wide, acuminate, with greenish midline and whitish subscarious margin, the outer puberulous throughout, the middle puberulous on back above, the inmost glabrous except for the ciliolate tip; pistillate heads 5 mm. high, thick-cylindric (when moistened), 20–21-flowered, the pistillate flowers 18–20, the hermaphrodite 1–2; pistillate corollas about 2.7 mm. long, the tube slender, densely puberulous at apex, otherwise essentially glabrous, about 1.7 mm. long, the ligule erect, elliptic or oblong, concave, emarginate or 3-denticulate, 0.8–1 mm. long, white; hermaphrodite (staminate) corollas 3.2 mm. long, whitish, the tube 1.5 mm. long, sparsely puberulous, the limb 1.7 mm. long, campanulate, divided to the very base into 5 teeth, these oblong, acute, obscurely puberulous dorsally, about 0.4 mm. wide; achenes (scarcely mature)

of pistillate flowers oblong, strongly compressed, 4-nerved, rather densely hirsutulous, 1.4 mm. long, those of the hermaphrodite flowers inane, linear-oblong, densely hirsutulous, 1.2 mm. long; pappus of slender whitish bristles, about 3 mm. long; style branches of hermaphrodite flowers lance-oblong, very acute, hispidulous, about 0.7 mm. long; staminate plant unknown.—COCLÉ: vicinity of El Valle, alt. 100–800 m., Sept. 5, 1938, *P. H. Allen 751* (U. S. Nat. Herb., No. 1,793,562, TYPE).

Nearest *Archibaccharis irazuensis* Blake, in which the leaves are lanceolate and acuminate, the phyllaries broader, firmer, and less pubescent, the stem-pubescence longer, and the floral details different. In *A. irazuensis* the heads are 31–39-flowered, with 3–6 hermaphrodite flowers; the pistillate corollas are tubular-filiform, without ligule; and the hermaphrodite corollas have a definite throat (about 0.7 mm.), half as long as the teeth or more. *A. panamensis* appears to inhabit a very different life zone, since the recorded altitudes for specimens of *A. irazuensis* examined run from 1500–1900 to 2700–3000 meters in Costa Rica, and 3500–4000 meters in Panama (see below).

The genus *Archibaccharis* has not hitherto been known south of Costa Rica. Two additional species can also be recorded from Panama:

ARCHIBACCHARIS IRAZUENSIS Blake.—CHIRIQUÍ: Volcán de Chiriquí, between Potrero Muleto and summit, alt. 3500–4000 m., July 13–15, 1940, *Woodson & Schery 463*. Previously known from Volcan Irazú and its vicinity, and from the Cerro de las Vueltas in the Province of San José, Costa Rica.

ARCHIBACCHARIS TORQUIS Blake.—CHIRIQUÍ: vicinity of Callejón Seco, Volcán de Chiriquí, alt. 1700 m., July 17, 1940, *Woodson & Schery 481*. Previously known from Vera Cruz to Costa Rica.

PTEROCAULON ALOPECUROIDES (Lam.) DC.—PANAMÁ: hills above Campana, alt. 600–800 m., Dec. 23, 1938, *Allen 1325* (U. S. Nat. Herb.). Previously known from the West Indies and northern South America. The genus, apparently, has not been

recorded heretofore from the Mexican-Central American region.

CLIBADIUM **sessile** Blake, sp. nov. Frutex; caulis (supra) 6-angulatus striatus parce strigillosus; folia elliptico-lanceolata acuminata basi longe cuneata sessilia crenato-serrata pergamentacea longe supra basin triplinervia supra sparse tuberculato-strigillosa non aspera aetate bullata subtus aequaliter strigillosa ca. 14 cm. longa 4 cm. lata; panicula parva 4 cm. lata terminalis adscendenti-pilosa; capitula parviuscula 4–5 mm. alta sessilia per 3–6 glomerata, glomerulis 5–7 mm. diam. ca. 12 in pedunculis partialibus 4–6 mm. longis; phyllaria 2 ovata obtusa appressa 5–9-nervia breviter ciliata et prope apicem strigillosa; flor. fem. 3, hermaph. 6; receptaculum intra flor. fem. solum 1-paleatum; ovarium fem. glaberrimum.

Shrub 2 m. high; stem sparsely strigillose with subtuberculate-based hairs, whitish-pithy, 3 mm. thick above; upper internodes 5–8 cm. long; upper leaves 10–14.5 cm. long, 2.5–4 cm. wide, broadest near or slightly above the middle, acuminate to an obtusish callous tip and somewhat falcate, cuneate at base (the cuneate base entire, 3–5 cm. long), crenate-serrate with about 9–24 pairs of depressed callous-tipped teeth (these 0.5–1 mm. high, 3–9 mm. apart), above brownish green, evenly but not densely tuberculate-strigillose with mostly deciduous hairs with small persistent lepidote bases, more densely antrorse-strigose along the chief nerves, essentially smooth to the touch, in age slightly shining and somewhat bullate with impressed veins and veinlets, beneath lighter brownish green, uniformly but not densely strigillose on surface and veins, triplinerved 3–4 cm. above the base, 4–5 mm. wide at base, the bases of each pair not connate; panicle small, much surpassed by the upper leaves, more or less ternately divided, the peduncle 2 cm. long, the panicle as long, the bracts small, linear, 7 mm. long or less, subscarious; phyllaries (in flower) brownish, 3.2–3.7 mm. long, 2–2.3 mm. wide; pistillate flowers all paleate, their pales similar to the phyllaries, their ovaries (immature) obovoid, obcompressed, perfectly glabrous, 1.2 mm. long, with a distinct inflexed beak, their corollas cylindric, 2-

toothed, white, glabrous, 1.6 mm. long; single pale of the disk oblong, obtuse, ciliate, 2.5 mm. long; ovaries of the hermaphrodite flowers villous at apex, their corollas (immature) white, 2.5 mm. long, hispidulous on the teeth.—CHIRIQUÍ: vicinity of Bajo Chorro, alt. 1900 m., July 20–22, 1940, *Woodson & Schery 658* (U. S. Nat. Arb. No. 124226, TYPE).

The only close ally of this species is *C. subsessilifolium* Hieron., of Ecuador, fragments from the type of which are in the U. S. National Herbarium. In that species the branches are described as "setose-hirtous with erect hairs" [Hieronymus] or "villous with erect hairs" [O. E. Schulz], the leaves are very rough above, antrorse-hirsute beneath, the larger subcordate at base, and the phyllaries are narrowly ovate, acuminate, 5 mm. long, with recurved reddish apex.

RUMFORDIA POLYMNIOIDES Greenm.—CHIRIQUÍ: vicinity of "New Switzerland," central valley of Río Chiriquí Viejo, alt. 1800–2000 m., Jan. 6–14, 1939, *Allen 1413* (U. S. Nat. Herb.). Previously known only from Costa Rica.

LIABUM POLYANTHUM Klatt.—CHIRIQUÍ: Chiriquí Viejo Valley, April 26, 1938, *G. White 93* (U. S. Nat. Herb.); vine climbing to 8 m. on stumps, vicinity of "New Switzerland," central valley of Río Chiriquí Viejo, alt. 1800–2000 m., Jan. 6–14, 1939, *Allen 1415* (U. S. Nat. Herb.). Previously known only from Costa Rica.

LIABUM SAGITTATUM Sch. Bip.—CHIRIQUÍ: trail from Cerro Punta to head-waters of Río Caldera, alt. 2250–2500 m., Jan. 14, 1939, *Allen 1458* (U. S. Nat. Herb.). Not previously known north of Colombia.

JUNGIA FERRUGINEA L.f.—CHIRIQUÍ: vicinity of "New Switzerland," central valley of Río Chiriquí Viejo, alt. 1800–2000 m., Jan. 6–14, 1939, *Allen 1367* (U. S. Nat. Herb.); liana climbing 30 m. into tops of largest trees, vicinity of Cerro Punta, alt. 2000 m., Jan. 21–24, 1939, *Allen 1520* (U. S. Nat. Herb.). Previously known from Costa Rica and northern South America.

Explanation of Plate

PLATE 19

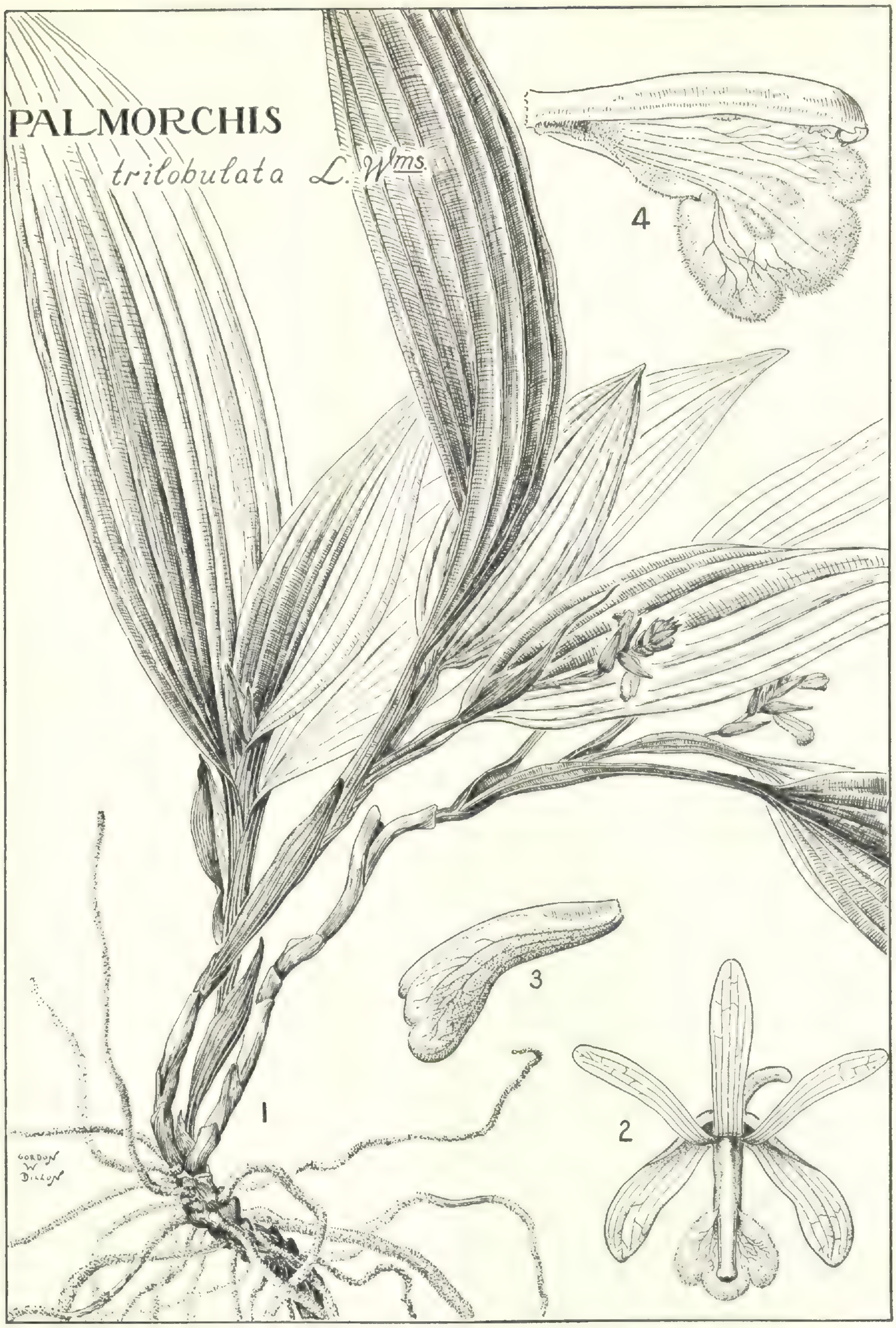
Aechmea Allenii L. B. Smith. From type specimen, *P. H. Allen 2378,* in the United States National Herbarium.

WOODSON & SCHERY—FLORA OF PANAMA

EXPLANATION OF PLATE

PLATE 20

Palmorchis trilobulata L. O. Williams: fig. 1, plant, × ½; fig. 2, flower opened out, × 2; fig. 3, lip and column from the side, natural position, × 3; fig. 4, column and lip with the lip expanded, × 4.



WOODSON & SCHERY—FLORA OF PANAMA

EXPLANATION OF PLATE

PLATE 21

Figs. 1–6. *Pleurothallis macrantha* L. O. Williams: **fig. 1, plant, ×½; fig. 2,** flower opened out, × 1½; fig. 3, flower from the side in natural position, × 1½; fig. 4, lip from the side, × 3; fig. 5, lip from above with one basal lobe spread out, × 3; fig. 6, cross-section through the middle of the lip, × 3.

Figs. 7–10. *Epidendrum gibbosum* L. O. Williams: fig. 7, plant, × ½; fig. 8, flower expanded, × 2; fig. 9, lip from the side in natural position, × 2; fig. 10, floral bract, × 1.

PLEUROTHALLIS
macrantha L. Wms.
1
2
3
4
5
6
7
8
9
10
GORDON W. DILLON
EPIDENDRUM
gibbosum L. Wms.

EXPLANATION OF PLATE

PLATE 22

Figs. 1–2. *Epidendrum ellipsophyllum* L. O. Williams: fig. 1, plant, × ½; fig. 2, flower opened out, × 1½.

Figs. 3–5. *Epidendrum Allenii* L. O. Williams: fig. 3, plant, × ½; fig. 4, flower opened out, × 1½; fig. 5, column (and base of the lip) from the side, × 2½.

EPIDENDRUM ellipsophyllum L. Wms.
2
1
5
3
4
E. Allenii L. Wms.
GORDON W. DILLON

Explanation of Plate

PLATE 23

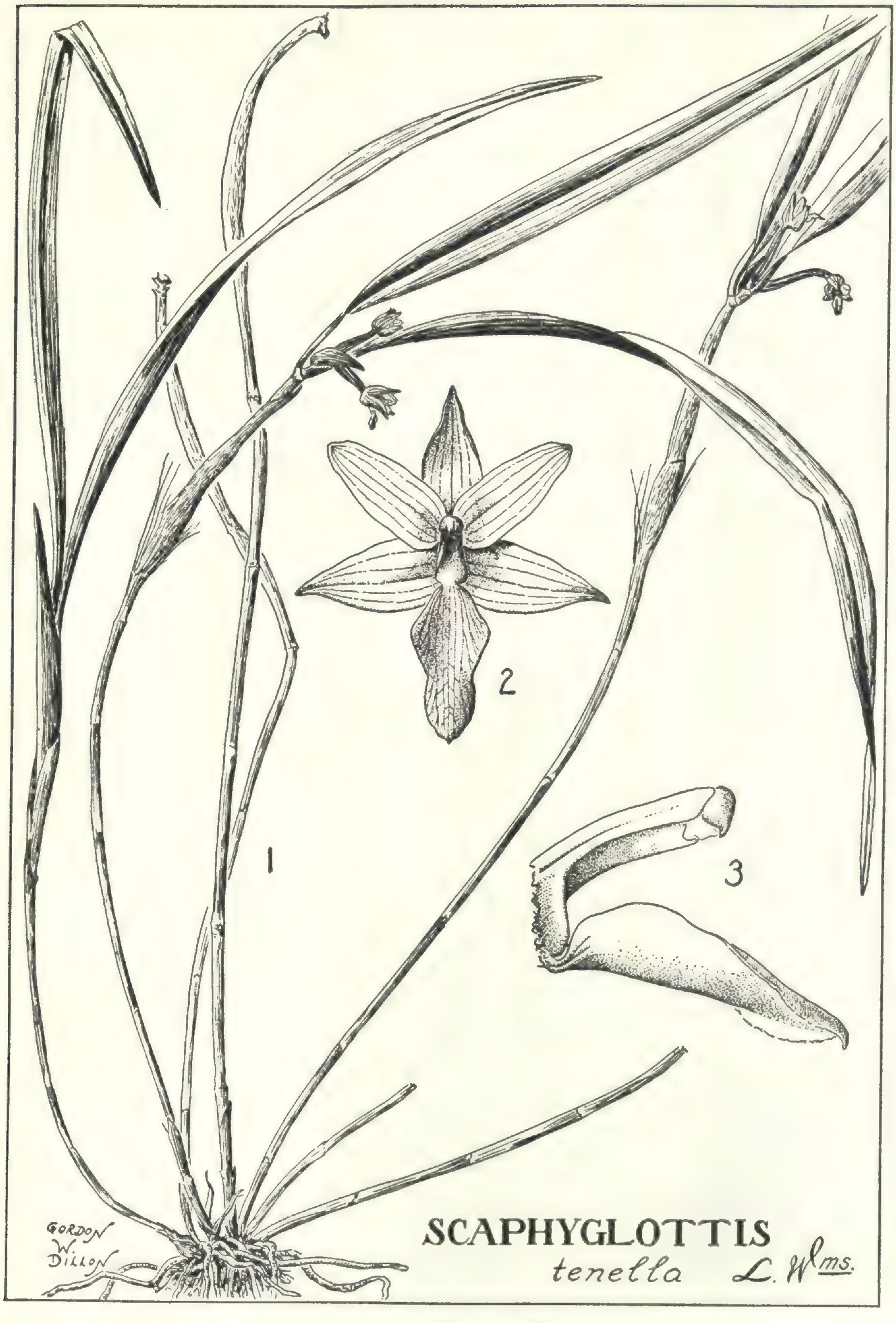
Epidendrum pendens L. O. Williams: fig. 1, plant × ½; fig. 2, flower opened out, × 1.

WOODSON & SCHERY—FLORA OF PANAMA

EXPLANATION OF PLATE

PLATE 24

Scaphyglottis tenella L. O. Williams: fig. 1, plant, × ½; fig. 2, flower opened out, × 2½; fig. 3, column and lip from the side, × 5.



WOODSON & SCHERY—FLORA OF PANAMA

Explanation of Plate

PLATE 25

Zygopetalum parviflorum **L. O. Williams: fig. 1, plant, × ½; fig. 2, flower opened out, × 2; fig. 3, lip extended, × 4.**

WOODSON & SCHERY—FLORA OF PANAMA

THE CYTOGENETICS OF POA PRATENSIS[1]

WILLIAM L. BROWN

Cytogeneticist, United States Golf Association, Green Section, Washington, D. C.
Formerly Research Fellow, Henry Shaw School of Botany
of Washington University

Introduction

Poa pratensis L., the common Kentucky Blue grass, is universally recognized by taxonomists as an extremely variable species. Many different strains are included within the species, and although American botanists do not generally recognise them as being sufficiently distinct to warrant their segregation from *pratensis* they are conspicuously present. Basic information on their variability, inheritance, and methods of reproduction would not only make it possible to classify the various strains more efficiently but it would allow us to use the species to best advantage for pasturage, turf, etc. It would also indicate what improvements might be expected by breeding for superior strains and the methods to be followed in making such improvements.

In this investigation an attempt has been made to correlate data from morphological, cytological, and genetical studies in an effort to arrive at a clearer understanding of the behavior of the species.

Materials and Methods

Materials for this study have, for the most part, come from the Missouri Botanical Garden Arboretum, Gray Summit, Missouri. In the spring and summer of 1941 additional data have been obtained from plants growing in the nurseries of the United States Golf Association, Green Section, at Arlington, Virginia. Most of these plants came originally from estab-

[1] An investigation carried out at the Missouri Botanical Garden in the graduate laboratory of the Henry Shaw School of Botany of Washington University and submitted as a thesis in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

lished turf selected at various places throughout the United States.

At the Missouri Botanical Garden Arboretum eleven lots of seed from well-established clones were harvested in 1939, all being taken from open-pollinated panicles. The parent clones varied in width from 1 to 3 feet and were growing in an area approximately 50 feet square. There was therefore considerable opportunity for cross-pollination between clones. Seed was sown in the greenhouse the first week in January 1940. In February individual plants were transferred to 2-inch pots and removed to a cool greenhouse. They remained here until April, at which time they were moved to the nursery.

Both permanent and smear methods have been employed in cytological studies. La Cour's 2 BD fixative was used in all cases where permanent preparations were desired. The Feulgen staining technic, supplemented by crystal violet and aceto-carmine, was used to advantage.

PROGENY ANALYSES

G.S. Lot 1.—Seeds from open-flowering panicles were collected from a single clone in 1939. The resulting progeny was analyzed after two year's growth, i. e., after the plants had reached full maturity. Of 133 plants in the family, 131 were uniform and morphologically closely resembled the mother parent. These were of tall upright habit, possessing relatively narrow leaves and average-size panicles. The two aberrant plants were easily distinguished by their low habit of growth, darker green color, and wider leaves.

G.S. Lot 2.—In this lot 103 plants were grown to maturity, 102 of which were morphologically constant and indistinguishable from the female parent. They resembled those of Lot 1 very closely and were definitely of the "hay" type. They were tall, with narrow leaves and panicles of medium size. The one aberrant plant was a low, spreading type with wide leaves and a heavy inflorescence. It resembled somewhat the "off types" in Lot 1, but deviated from the maternal parent even more than the aberrants of the first lot.

G.S. Lot 3.—Of the 100 plants composing this progeny all were absolutely uniform, with growth habit and morphology resembling closely those of the first two lots.

G.S. Lot 4.—These plants represent a type very different from those of the previous lots. They are characterized by low growth, light green leaves, and small purple inflorescences. Fifty-five seedlings were raised to maturity, all of which were absolutely uniform and indistinguishable from the maternal parent.

G.S. Lot 5.—The parent of this lot of plants was of tall upright growth habit. The leaves were slightly more than medium width and dark green in color. Panicles were of average size. Progeny of this parent, consisting of 55 plants, may be segregated into two distinct classes: (1) those identical with the parent, to which class belong 45 of the plants; (2) 10 plants with lax, glossy, light green leaves almost twice as wide as those of the parent, and inflorescenses extremely long and heavy. By observation alone one could easily place each of the plants into one of these two classes. No intermediates occurred.

G.S. Lot 6.—Of the 60 plants comprising this selection, all were uniform with the exception of some slight differences in time of flowering. However, this variation can hardly be referred to as of a genetic nature since it might easily be the result of soil heterogeneity, differences in soil moisture or disturbances from cultivation.

G.S. Lot 7.—This progeny, consisting of 60 plants, was of a type almost identical with Lot 1. They were strikingly uniform throughout and showed no morphological deviation from the parents.

G.S. Lot 8.—As a whole, these plants resembled the aberrants of Lot 3. They are characterized by tall culms, wide, lax, light green leaves, and very long panicles. The progenies were surprisingly uniform and, with one exception, quite similar morphologically to the maternal parents. The one aberrant in a progeny of 60 plants possessed stiff, narrow, dark green leaves and a small, almost dwarfed inflorescence.

G.S. Lot 9.—The 60 plants grown to maturity were uniform throughout and indistinguishable from the maternal parent.

G.S. Lot 10.—The plants from which seed for this progeny was collected were characterized by low, spreading growth and very vigorous habit. The leaves were wide (5–6 mm.) and dark green in color. Panicles were large, heavy, and late-flowering. Fifty of the 60 seedlings closely resembled the female parents morphologically, while the other 10 were variants. However, as has been shown for Lot 5, the variants were quite uniform among themselves. All 10 plants fell into a class characterized by narrow leaves and small panicles.

G.S. Lot 11.—These plants were typical "hay" type with tall upright growth, moderately narrow leaves and average-size panicles. The parent clone was of this general type and 53 of the 55 plants grown from seed were almost identical with the parent. The two aberrants differed markedly from the typical plants. They were a low, spreading, wide-leaved type with very long heavy panicles.

TABLE I

SUMMARY OF MORPHOLOGICAL VARIATION IN GRAY SUMMIT PROGENIES

	Number of plants	Number of aberrants	Per cent aberrants
G.S.– 1	133	2	1.50
G.S.– 2	103	1	0.97
G.S.– 3	100	–	–
G.S.– 4	55	–	–
G.S.– 5	55	10	18.18
G.S.– 6	60	–	–
G.S.– 7	60	–	–
G.S.– 8	60	1	1.66
G.S.– 9	60	–	–
G.S.–10	60	10	16.66
G.S.–11	55	2	3.63

All the plants described in the foregoing paragraphs were obtained from seed collected from open-pollinated panicles. With the exception of Lots 5 and 10, these progenies have been quite uniform and very similar to the maternal parents.

The Arlington plants were subject to a somewhat different

method of study. The seed had been harvested from single isolated plants in nursery rows. Collection was made not only from open-pollinated panicles but from inflorescences that had been isolated from foreign pollen by bagging prior to anthesis. In some instances seed-setting in parchment isolation bags was very poor, but enough seed was always produced for progeny analyses. Seedlings were started in the greenhouse and then transferred to nursery rows. Those from free-flowering and isolated panicles of the same plant were placed in adjacent rows for comparison. At the height of their flowering season they were analyzed morphologically in the same manner as were the G.S. progenies.

The contrast between progenies from isolation and open-pollination was sometimes very marked (pls. 28–29). For example, B-2 after open-pollination produced a uniform and maternal-like progeny typical of apomictic strains. The selfed progeny of this line, however, showed a degree of variation that might be expected only from sexually reproducing plants. Even before flowering, distinct differences between plants could be easily ascertained from vegetative characters, the variability in leaf width being especially noticeable (figs. 1 and 2). At the time of flowering distinct differences in the inflorescences, including size of panicles, number of florets per spikelet, etc., were evident. There also occurred in the selfed line of this progeny a number of weak plants, many of which did not survive beyond the seedling stage. Other weak plants which were grown to maturity exhibited characters entirely foreign to *P. pratensis.*

Another example of very distinct differences in open and selfed lines of the same strain is provided by selection B-6. Here also the progenies grown from open-pollinated panicles were uniform and exhibited a tall upright habit of growth (pl. 28). The progeny produced after isolation, although not quite so variable as the selfs in B-2, was of an entirely different growth habit from that produced after open-pollination, almost without exception being low-growing, spreading, semi-decumbent types (pl. 29).

In contrast to the B-2 and B-6 seedlings, those of B-17 and B-1 showed absolutely no differences between open and selfed lines, and all were essentially maternal-like in appearance (pls. 26 and 27).

In addition to the three strains mentioned above, progenies of open and selfed lines of eleven other selections were grown

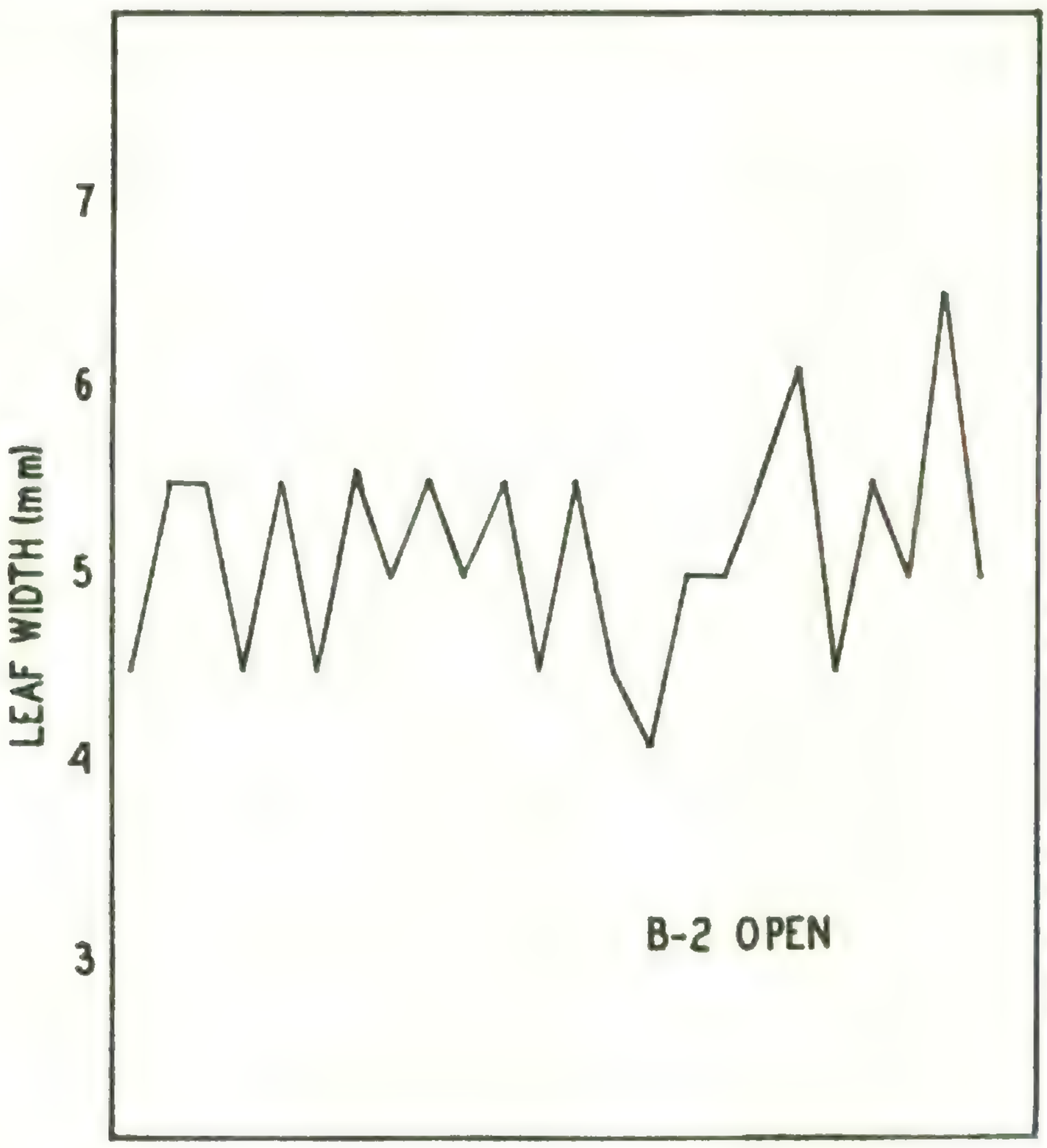


Fig. 1. Variation in leaf width in B-2 progeny after open-pollination.

to maturity and analyzed. Six of these progenies showed very marked differences in the number of aberrants occurring after selfing and after open-pollination, the selfed line always producing more variable types than the open-pollinated one. Strains which had previously been concluded to be apomictic behaved as sexually reproducing plants when they were isolated from foreign pollen. When segregation of a degree ex-

hibited by some of these selfed lines does occur it must be assumed that reproduction has taken place by gametic union. If this is true, what is there to prevent the open-pollinated lines of the same plant from functioning in a like manner? Assuming that the plant is potentially sexual, one might logically have expected the open-pollinated lines whose parents are sub-

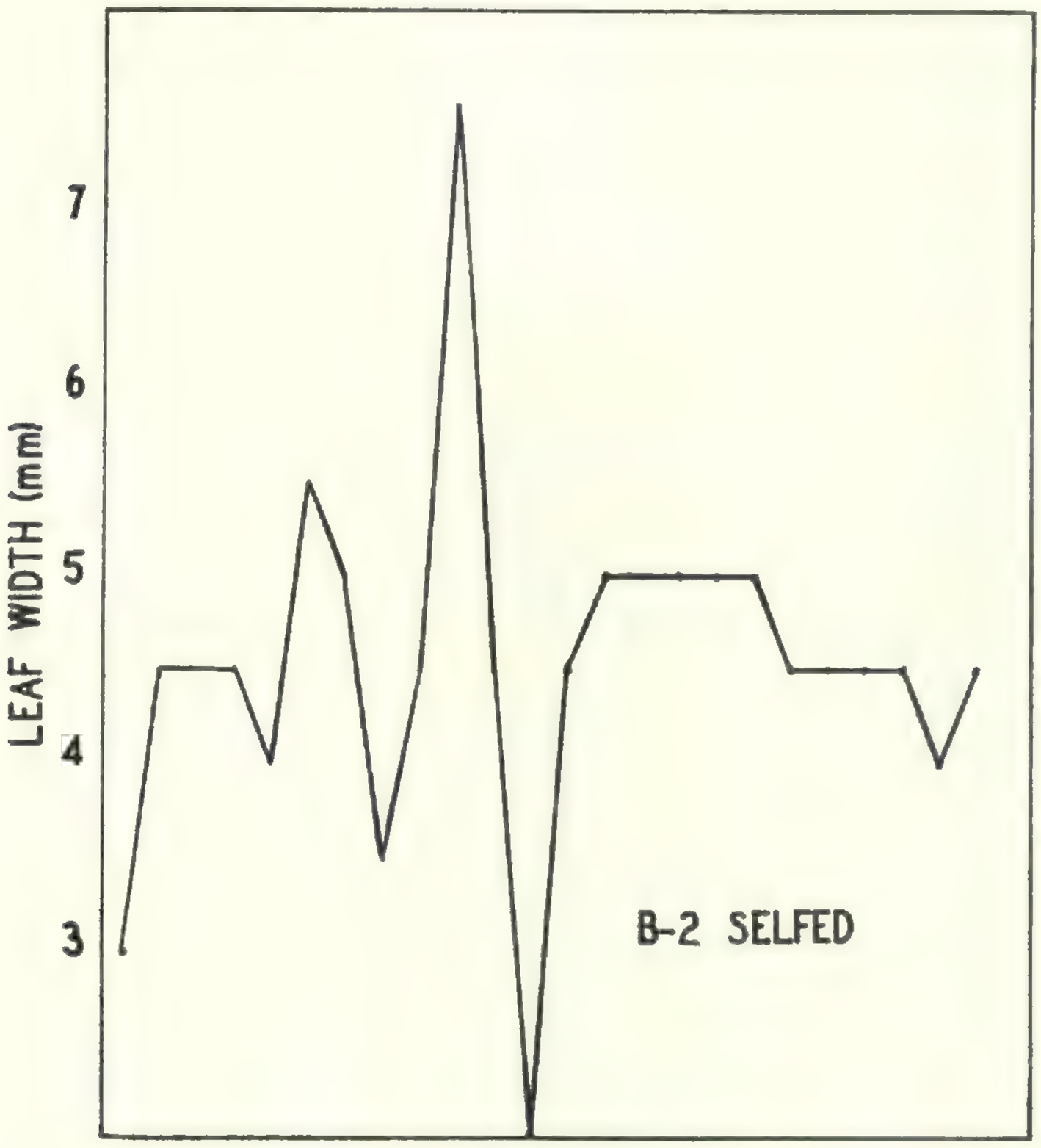


Fig. 2. Variation in leaf width in B-2 progeny after selfing.

ject to cross-pollination with other plants to exhibit more variation than the selfs. This, however, did not occur.

As a result of these analyses it is concluded that there are within *Poa pratensis* both sexual and asexual strains. Although the asexual strains are apparently predominant, the sexual ones occur frequently in most populations. Aside from purely sexual and purely asexual strains, there are those

plants which apparently reproduce asexually when open-pollinated but which reproduce sexually when selfed.

CHROMOSOME STUDIES

The polyploid nature of the genus *Poa* has long been established with 7 as the accepted base number. Within *Poa pratensis* somatic chromosome numbers range from 28, recorded by Avdulow ('31), to 110. This extensive polyploid series is not confined to euploidy, but a great many aneuploid numbers have been reported. The modal chromosome number for the species has been established as 56, Brown ('39). These 56-chromosome types are, for the most part, representative of average Blue grass, that is, they are of tall, upright habit, possess moderately narrow leaves, and average approximately three florets per spikelet.

Unfortunately, few correlated cytological and morphological data are available on *P. pratensis*. Müntzing ('40) makes some mention both of the cytology and morphology of some of the biotypes with which he has worked. Over a period of years I have observed that those low-growing plants with wide leaves, large spikelets, and heavy inflorescences have, with few exceptions, lower chromosome numbers than do those with narrow leaves, small spikelets, and average-size inflorescences. In fact, there is considerable evidence that approximately 6n is the optimum for chromosome increase beyond which there is a marked decline in vigor.

In the present investigation no effort has been made to obtain even random chromosome numbers from a great many lots of plants. Instead, one lot was selected from which it was felt that chromosome data would be of particular significance. The great majority of progenies, after open-pollination, exhibited little, if any, variation and were eliminated as possible material for chromosome studies. After studying the morphological variability in G.S. Lot 5 it was immediately apparent that chromosome data from this progeny would be of special interest.

It will be remembered that the progeny of Lot 5, after open-

pollination, segregated into two distinct classes. Forty-five of the 55 plants were typical of the maternal parent while the remaining 10 were of a very different morphological type. Cytological examination of 35 of these plants has yielded some very interesting facts on the morphological effects of chromosome elimination from the original complement. The typical plants of the progeny, for the most part, possessed 49 somatic chromosomes (table II). The "off types," or aberrants, all of which belonged to a single morphological type, were, with one exception, shown to have 42 chromosomes, or one less genom than the typical plants. Thus the change from a moderately narrow-leaved, upright "hay" plant to a wide-leaved, low-growing one with increased vigor is the result of the elimination of one genom from the germ-plasm. The fact that all but one of the aberrant types contained one less genom instead of from 1 to 7 fewer chromosomes is of considerable interest. A number of 2n plus 1-, 2-, or 3- or 2n minus 1-, 2-, or 3-chromosome types have been investigated in other plants *(Zea, Datura,* etc.), and in most such cases the elimination or addition of even one chromosome was usually morphologically apparent. This, however, is not true in those plants of *P. pratensis* that have been studied. One of the typical plants (G.S. 5–5) possessed 47 chromosomes, yet it could not be morphologically distinguished from those with 49 chromosomes.

A few scattered chromesome counts have been made on plants selected from lots other than G.S. 5. Although these are so few that no conclusions can be drawn concerning the cytology of the lots as a whole, the following bit of information is of some interest. Lot 1, it will be recalled, produced a very low percentage of aberrants and is apparently an apomictic strain. Chromosome counts were made from six plants of this lot, and in all the 2n number was found to be 56. Four out of five plants from Lot 2, another apomictic strain, were found also to possess 56 chromosomes. The number for the fifth plant could not be exactly determined but it was between 55 and 58. Lot 10, which reproduces at least partially by gametic union, yielded plants with 42, 41, and 42 ± 1 chromosomes.

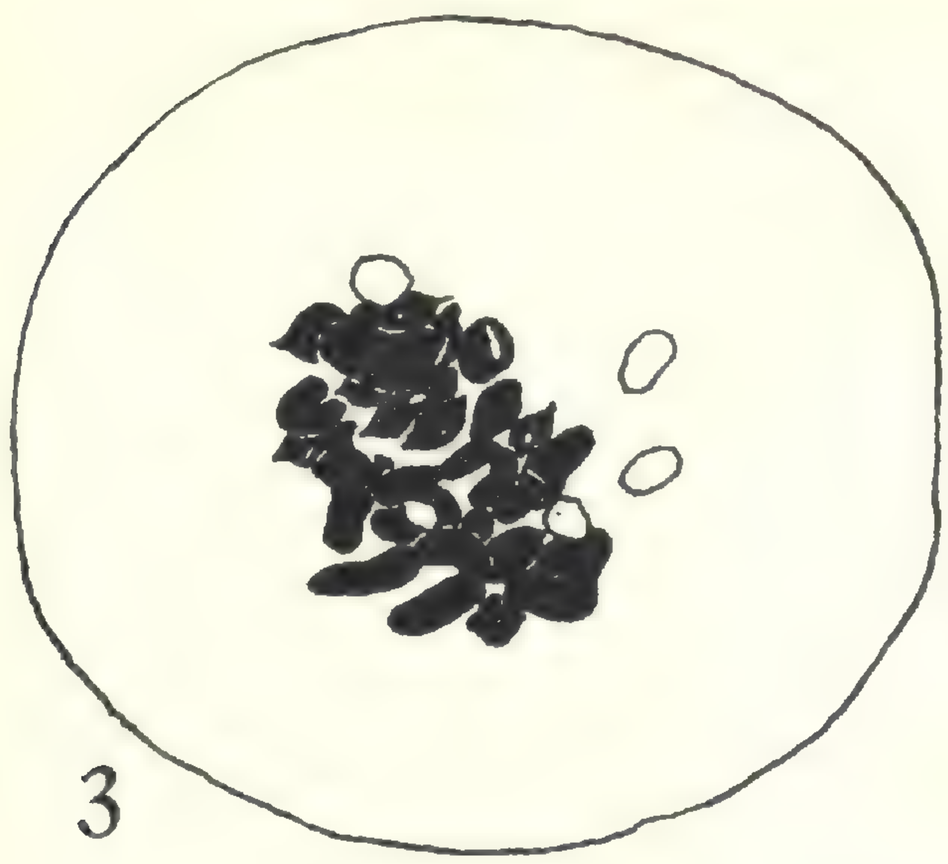
These data suggest that apomixis may be more prevalent in the higher chromosome types and that polyploids of approximately 6n reproduce sexually.

TABLE II

SUMMARY OF CHROMOSOME NUMBERS IN G.S. LOT 5

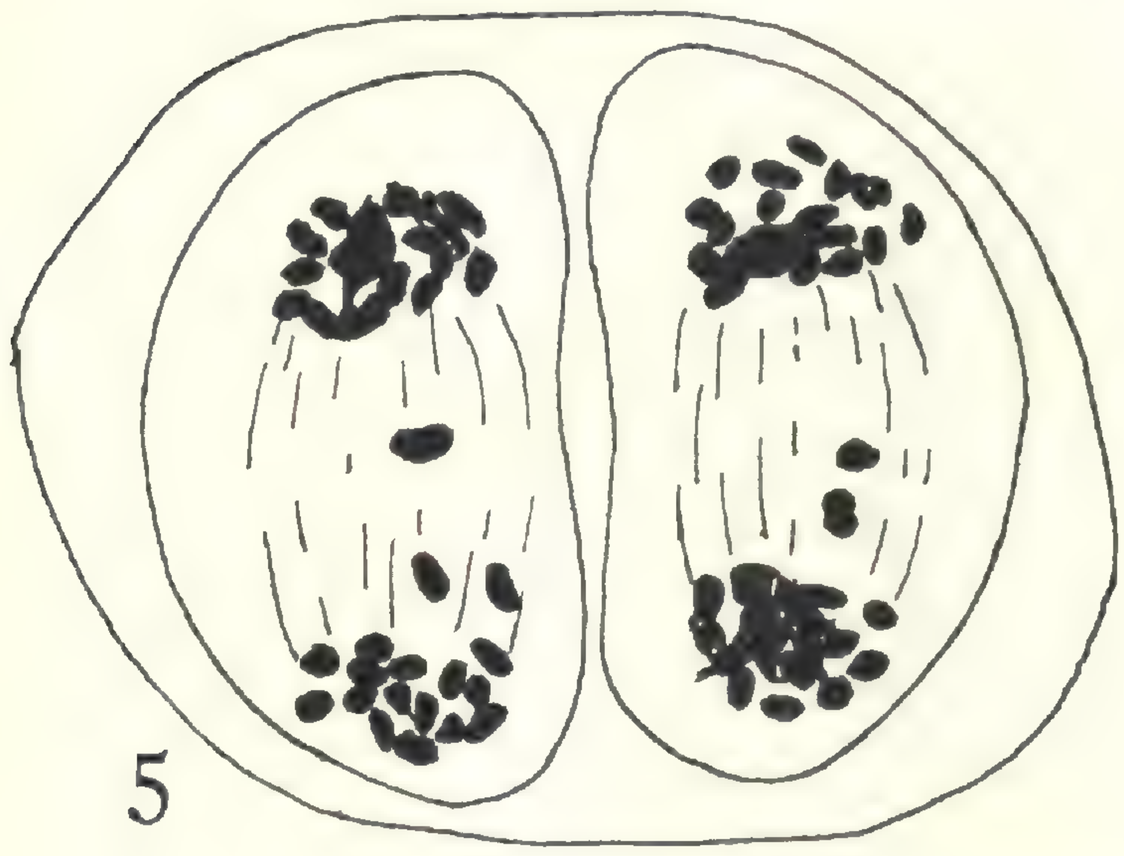
Plant	2n	Type of plant
5– 1	49	Typical
5– 2	42	Aberrant
5– 3	49	Typical
5– 4	49	Typical
5– 5	47	Typical
5– 6	49	Typical
5– 7	48–49	Typical
5– 8	48±1	Typical
5– 9	42	Aberrant
5–10	49–50	Typical
5–11	49	Typical
5–12	49	Typical
5–13	49	Typical
5–14	49	Typical
5–15	49	Typical
5–16	42	Aberrant
5–17	49	Typical
5–18	49	Typical
5–19	49	Typical
5–20	48–49	Typical
5–21	43±1	Aberrant
5–22	42	Aberrant
5–23	49±1	Typical
5–24	49	Typical
5–25	49–50	Typical
5–26	49±1	Typical
5–27	49	Typical
5–28	41–42	Aberrant
5–29	49	Typical
5–30	49	Typical
5–31	49	Typical
5–32	50	Typical
5–33	42	Aberrant
5–34	49–50	Typical
5–35	49	Typical

Meiosis: Osbervations on meiosis were made on a number of plants whose chromosome numbers had been previously determined somatically. Although meiosis in *P. pratensis* is not regular, the irregularity is not of a degree that might be expected in a highly polyploid species (figs. 3–13). Pairing is, for the most part, by bivalents, although univalents, trivalents, and quadrivalents have been observed in all cells examined.



3

4



5

6

7

8

Figs. 3–8. Camera-lucida drawings of meiotic chromosomes in *Poa pratensis*, × 2000: fig. 3. Metaphase I from an apomictic plant showing 4 univalents, 3 trivalents, and approx. 23 bivalents, univalents in outline; fig. 4. Anaphase I from apomictic plant showing univalents dividing—not all polar chromosomes shown; fig. 5. Anaphase II showing lagging; fig. 6. Univalents dividing at Anaphase I, sexual plant; fig. 7. Metaphase I showing non-conjugation in apomictic plant; fig. 8. Anaphase I depicting unequal distribution with a dicentric chromosome.

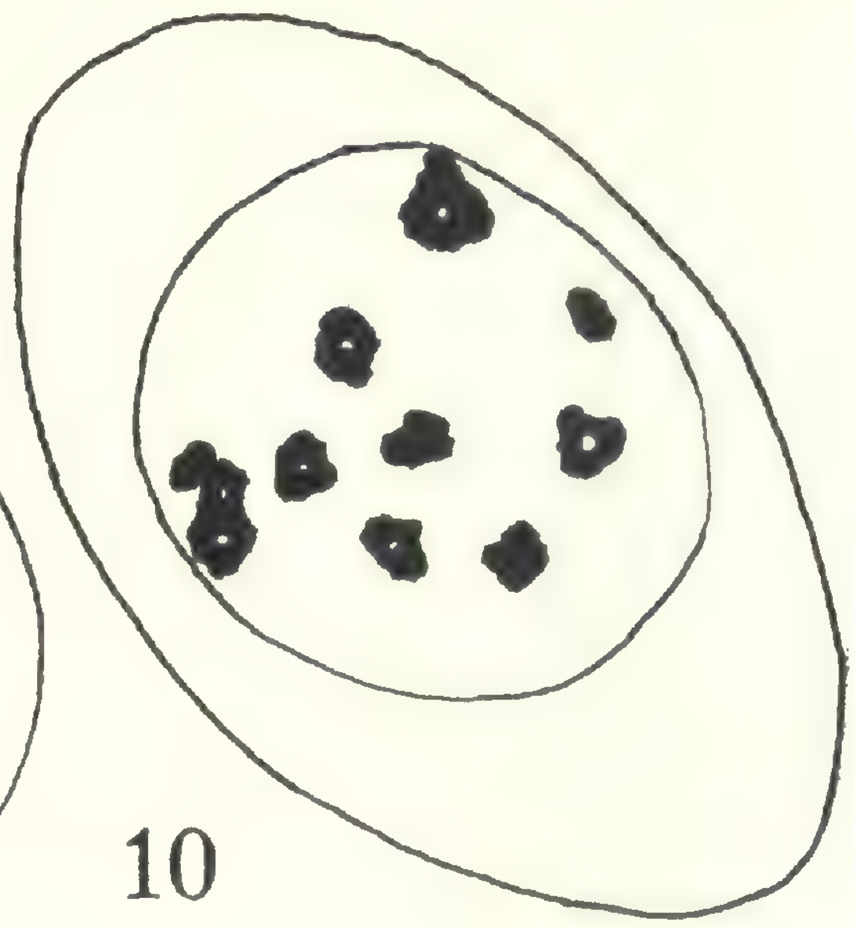
The majority of the bivalents are ring-shaped, averaging two chiasmata. Figure 11 represents a meiotic configuration which is rather typical of 42-chromosome plants. At Metaphase I the configuration consists of 17 II's, 4 I's, and 1 IV. At first anaphase most of the univalents divide after lagging in the region of the equatorial plate (fig. 12). The 56-chromosome plants show no more meiotic irregularity than do the hexaploids (fig. 3). The configuration at Metaphase I consists usually of 1–2 IV's, 1–2 III's, approximately 4 I's, with the remaining chromosomes paired as bivalents. Univalents usually lag at Anaphase I, but they always reach the poles in time to be included in one or the other of the polar groups. Distribution is, with very few exceptions, fairly equal at the anaphases. The tetrads and microspores appear to be normal, and micronuclei have not been observed in any of the cells examined. Some plants are obviously heterozygous for an inversion or duplication as indicated by the occasional occurrence of dicentric chromatids (fig. 8).

APOMIXIS

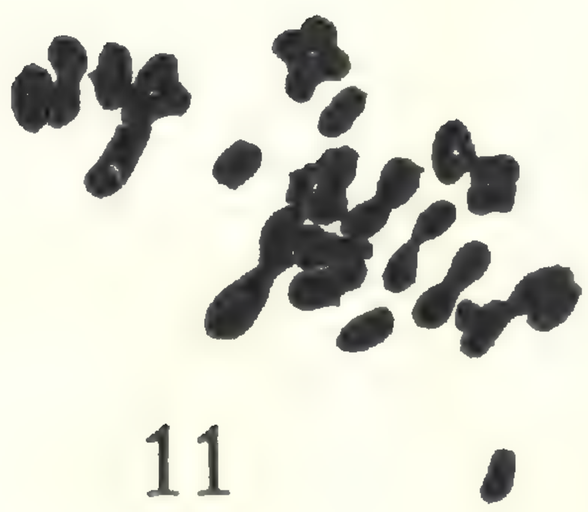
The occurrence of apomixis in *Poa pratensis* was first shown by Müntzing ('33). He studied a number of plants representing eight biotypes. A large percentage of his material was found to have aneuploid chromosome numbers, and for the most part the numbers within biotypes remained constant. Since the individual plants composing any one biotype exhibited little morphological variation, Müntzing assumed them to be apomictic. In a study of twin seedlings in *Poa pratensis* he ('37) found a rather high occurrence of polyembryony, which he considered to be in some way correlated with apomictic propagation. He states further that . . . "formation of 'triploid' twin plants, however, resulting from fertilization of unreduced ovules, demonstrates that apomixis in *Poa pratensis* is not absolute."

Åkerberg ('36) investigated seed production in eighty biotypes of *P. pratensis*. After employing both emasculation and free-flowering methods he concluded that pollination was nec-

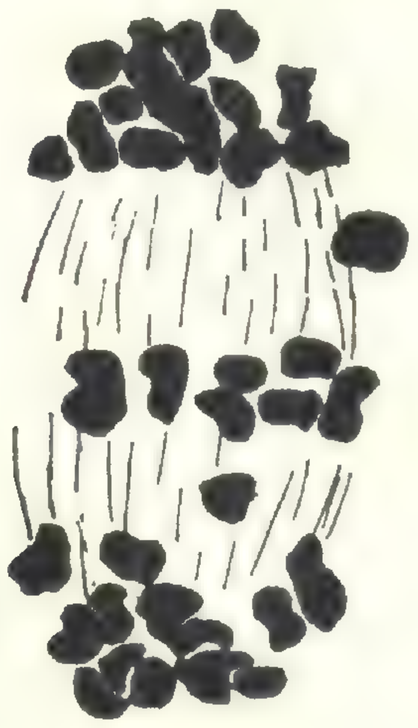
9



10



11



12

13

Figs. 9–13. Camera-lucida drawings of meiotic chromosomes in *Poa pratensis*, × 2000: figs. 9 & 10. Diakinesis in sexual plant, drawn in 2 planes—3 univalents, 16 bivalents, and 1 quadrivalent; fig. 11. Metaphase I from sexual plant showing 4 univalents, 17 bivalents, and 1 quadrivalent; fig. 12. Anaphase I from sexual plant showing lagging chromosomes—not all polar chromosomes shown; fig. 13. Metaphase chromosomes of fig. 11 drawn separately.

essary for seed production, but that pollen from *Poa alpina* had about the same effect as that from *P. pratensis*. For biotypes with aneuploid chromosome numbers and partial pollen sterility, Åkerberg postulated apomictic seed production. In a later investigation of progenies of *P. pratensis*, he ('39) attempts to determine the percentage of apomixis on the basis of morphological constancy. Of 703 plants investigated a little more than 90 per cent had the appearance of the maternal parents. These were assumed to be primarily apomictic and the 10 per cent of aberrants to be sexual. When 58 of the 703 plants were examined cytologically, 43 were found to have the same chromosome number as the mother plant; the remaining 15 were aberrants. Material was also collected from nature, and "of these 44 families, 37 were practically speaking morphologically constant."

Armstrong ('37) interprets the embryology of *P. pratensis* quite differently from the authors previously mentioned. Although he admits the occurrence of aneuploidy he still believes the species to be sexual and assumes that only gametes with certain chromosome numbers are capable of functioning. He has observed, in the embryo sac, a variation in the position of the functioning megaspore. This, he says, "provides a mechanism for the elimination of megaspores with an abnormal chromosome complement and for the choice of the megaspore containing the normal chromosome complement." On the basis of meiotic pairing he has assumed that 6/16 of the pollen would contain the normal chromosome complement, and he further states, "Assuming the same frequency of irregularity in megasporogenesis as in microsporogenesis, 6/16 of the megaspores would be normal, and with a choice of four megaspores the chance of obtaining one with the normal number is quite good."

Tinney ('40) found that the young ovules of *P. pratensis* always show a single, elongated, very conspicuous macrospore mother cell. The nucleus of this cell undergoes meiosis, and usually three haploid macrospores are formed, all of which subsequently disintegrate. The embryo sac arises from a cell

of the nucellus and when mature consists of three antipodals, a primary endosperm cell containing two nuclei and the egg apparatus. The diploid egg, according to Tinney, develops into a proembryo by parthenogenesis, the development beginning frequently before pollination. He did not observe endosperm development until after pollination and therefore concluded that pollination or the growth of pollen tubes in stylar tissue may be necessary for endosperm development and consequently seed development.

Tinney and Aamodt ('40) have analyzed 102 progenies of *Poa pratensis* in an attempt to arrive at the type of seed development in various biotypes. In 48 of them no variant types occurred, and these were thought to be apomictic. In one progeny, however, 21.9 per cent of the types were variant. These, it was thought, might have arisen through mutation or as a result of sexual reproduction.

Since all investigators of the mode of reproduction in *Poa pratensis* have shown that apomixis is one of the predominant factors involved, many have assumed that this phenomenon is of general occurrence within the species and can be taken advantage of in selection, etc. This assumption is to some extent undoubtedly true, but in view of the results obtained from this study it seems that we must distinguish between apomixis after selfing and apomixis after crossing or open-pollination.

Apomixis after Open-Pollination: It has been shown earlier that in lots B-2 and B-6 two very different types of progeny result when the same plants are selfed and allowed to produce seed without isolation. In plants reproducing by open-pollination the resulting progeny is essentially maternal-like morphologically and exhibit little, if any, variation within lines. Since *Poa pratensis* is an extremely diverse species it must, it seems, be assumed that constant morphological types of the nature just mentioned are being produced apomictically. The fact that foreign pollen must be present for the production of uniform progenies, however, is somewhat unusual and especially significant in the behavior of the species.

Apomixis after Selfing: If plants of strains B-2 and B-6 and

some other strains are isolated by bagging, progenies in direct morphological contrast to those obtained after open-pollination result. A wide range of variation both in vegetative and inflorescence characters usually results in these lines. Most of these strains segregate in a manner that would be expected only if the plant were reproducing sexually. These preliminary results indicate that in some strains of Kentucky Blue grass apomixis is dependent upon the presence of foreign pollen (pollen from another strain). The most logical hypothesis explaining the phenomenon is that the presence of foreign pollen on a stigma stimulates the development of some somatic cell of the embryo sac which, after the initial stimulation, goes ahead and functions as an embryo. Should the inflorescence of the same plant be bagged, thereby eliminating all foreign pollen, reproduction then takes place by gametic union (with the egg cell perhaps functioning normally). Besides explaining the differences in progeny obtained from the same plant after isolation and free-flowering, this hypothesis explains the varying but usually small percentage of aberrant forms present in most progenies of open-pollinated plants; i. e., they are the result of selfing, whereas the majority of the florets have received a stimulation from foreign pollen (as might be expected to occur in natural populations or in nursery rows).

The recent work of Englebert ('41) is very interesting in light of the results reported in this paper. Miss Englebert reports that in several species of *Poa,* including *Poa pratensis,* no endosperm was developed in emasculated, non-pollinated florets although embryos were found. She concluded, therefore, that the "germination of pollen on the stigmas stimulated the development of the aposporous polar cell to an endosperm (pseudogamy)." Although no embryological investigations have been attempted in the present study, the evidence from progeny analyses strongly indicates that in some strains of *P. pratensis* pollen plays a much more important role than the mere stimulation of endosperm development.

Several objections may be raised to the hypothesis just pre-

sented. For example, the increased temperature within a parchment bag might result in mutation and therefore in aberrant types. If this were true, however, one would expect comparable results in all selfed lines since the same methods of isolation were used in all plants investigated. As was noted earlier, this is not the case. Some strains, for example, B-6, produce nothing but uniform progenies regardless of whether or not the progenies are the product of isolation or open-pollination. As a further check on this point, three strains of *P. pratensis* which were thought to be apomictic were selected in 1940. Progenies of these were grown after (1) isolation by bagging, (2) isolation by caging, and (3) open-pollination. At maturity all three showed some slight random variation, but within any one strain there were no significant differences between plants produced under the different conditions. Yet in other selections which morphologically were almost identical with some of these lots, marked differences occurred in the number of variants produced after isolation and after open-pollination.

Behavior of Apomicts in Generations beyond the F_1*:* In most instances the demonstration of apomixis in Blue grass has been the result of progeny analyses based on one generation of plants. As a result, few data are available on the behavior of the supposed apomicts beyond the first generation. For example, it is not definitely known whether or not a selection of *Poa pratensis* which produces a uniform progeny in one generation will continue to do so in following generations, yet, for practical purposes in seed production and strain improvement, this information is necessary. Records obtained from three selections of *Poa pratensis,* each of which has been maintained for three plant generations, shed some light on this problem. In each of these selections progenies have been studied from both selfed and open-pollinated lines.

B-37.—The plant from which this line was started is typical of "average" Blue grass, i. e., it is upright in habit, has narrow dark green leaves, average-size panicles, and produces an abundance of seed. The first-generation seedlings obtained after free-flowering were uniform and very similar to the ma-

ternal parent. However, approximately 15 per cent aberrant types occurred in the selfed lines, and these exhibited a rather wide range of variability. The second and third generations behaved essentially in the same manner. The open-pollinated lines were again constant morphologically while the selfs showed considerable variation.

B-2.—Although a different type of plant morphologically, the B-2 progeny for three generations behaved very like that of B-37. The plants resulting from open-pollination showed no significant variation, although a number of "off types" occurred after selfing. These were, as a group, less vigorous and of a less desirable type than their parent. There were, nevertheless, a few exceptional cases in which promising segregates were obtained from selfed lines.

B-30-19.—In this strain, as in the two previous ones, asexual reproduction, resulting in uniform progenies, seems to function without change for at least three generations. In each generation, however, aberrant forms resulted from selfing.

TABLE III

VARIATION IN PROGENY OF OPEN-POLLINATED LINES

Selection number	Per cent aberrants		
	1939	1940	1941
B–37	4.32	3.81	4.00
B– 2	1.63	3.21	1.71
B–30–19	0.09	0.09	1.04

These results indicate that in apomictic or otherwise asexually reproducing strains of *Poa pratensis* progenies may be grown or strains may be reproduced by seed without the interference of segregation in later generations. Deviation from type amounting to from 1 to 5 per cent of the total population would not likely have an undesirable effect on these selections when used in pasturage or turf. However, it cannot be assumed that all *Poa pratensis* will behave in a manner exhibited by selections B-2, B-37, and B-30-19. As was shown earlier, G. S. Lot 5 and G. S. Lot 10 produce approximately 20 per cent

aberrants in progenies resulting from open-pollination. Deviations of this magnitude would soon result in a heterogeneous mixture if attempts were made to reproduce the types from seed.

Discussion

Amphimixis results in many and varied gene combinations and hence in an increased genetic morphological variability, but, due to a variety of both internal and external causes, only a small per cent of the gene combinations produced in any sexually reproducing species survives. As a result the majority of plant species remain more or less constant from generation to generation. There are, however, in the plant world a great many groups whose variability makes the delimiting of species exceedingly "difficult." It is interesting to note that the majority of these groups are those in which asexual reproduction is the predominant mode of propagation (Dobzhansky, '37). Under such a system any genetic change occurring within a species is not usually eliminated as it might well be if the species were sexual, but instead it is maintained and propagated vegetatively as a new clone. This soon develops into a variety of forms, a so-called "species complex." In *Poa pratensis* this condition is further accentuated by the operation of both amphimixis and apomixis within a single strain. Although evidence from progeny analyses indicates that the great majority of *Poa pratensis* strains reproduce normally by apomixis, in each of the progenies studied from 0.9 to 18 per cent of the offspring were found to be the product of sexual reproduction. In nature a great many of these "new" strains would be eliminated due to their inability to compete successfully with other strains, but a number of them might be expected to survive and these will, in many instances, further propagate their kind through apomixis. Thus it is evident that *Poa pratensis* is equipped not only for producing new or aberrant types but is especially well equipped for propagating these types vegetatively through seeds once they do occur.

Since both sexual and asexual reproduction have been demonstrated in *Poa pratensis*, information on the factors affect-

ing apomixis is a prime prerequisite to any strain-improvement program. However, little information is available on the causes of a breakdown in the sexual reproducing system in plants. Darlington ('37) has shown that when such a breakdown does occur it is usually replaced by some form of asexual reproduction. It has been further suggested that asexual reproduction may be the result of hybridization since many apomicts are known to be of hybrid origin. This is a possibility in *P. pratensis* which might well have originated as an alloploid hybrid.

Brown ('40) has shown that, despite the extreme variation exhibited by *P. pratensis*, there is a more or less constant grouping of all variables into two main complexes. One includes plants with wide leaves, many florets per spikelet, long and wide panicles, and many panicle branches. Into the other complex fall those plants with narrow leaves, few florets, short and narrow panicles, and few panicle branches. Regardless of what characters are considered or to what degree the variability may occur, the varying units always tend to group themselves into one of these two complexes. This suggests strongly that in the germ plasm of *P. pratensis* there are at least two entirely different elements. While it might be suggested that the differences between strains are a result of changes within the germ plasm, crossing-over, translocations, inversions, interchanges, etc., such differences would tend to occur at random and not in the distinct groups which have been demonstrated. It is impossible to prove conclusively the alloploid nature of *P. pratensis* without reproducing it artificially. Nevertheless, all its peculiarities point to a probable hybrid origin. Whether or not hybridization can be shown to be a basis for apomixis remains to be seen, but at least *P. pratensis* is another example of an apomictic species whose behavior is essentially that of a hybrid.

Chromosome Numbers and Apomixis: The correlation between per cent apomicts and chromosome number as exhibited in the G.S. plants is very interesting and perhaps significant. It will be recalled that in G.S. Lot 5 the chromosome numbers

were found to be either approximately 42 or approximately 49. This progeny contained 18.18 per cent aberrants. Likewise, G.S. Lot 10, containing 16.66 per cent aberrants, exhibited chromosome numbers of 42 and approximately 42. In contrast, six typical plants from Lot 1 and five from Lot 2 were found to have 2n numbers of 56. These lots yielded 1.50 and 0.97 per cent aberrants respectively. Although this evidence is not conclusive it does indicate that apomixis tends to increase as chromosome number increases. The evidence for a hybrid origin in the 42- and 49-chromosome plants is just as pronounced as it is in the octoploids. Therefore, according to these data, it must be assumed that chromosome duplication (perhaps following hybridization) is at least one of the factors affecting apomixis. On the other hand, it is not likely that any one or any few factors govern the operation of apomixis in *Poa*. Indeed, the isolation experiments suggest that the presence or absence of foreign pollen has a very marked effect on the functioning of asexual reproduction.

Genetics of the Various Genoms: Perhaps the most important contribution contained in this paper concerns the morphological effect of a duplication or elimination of chromosomes within a single strain. It is only logical to expect differences in morphological characters to be correlated with differences in chromosome numbers. Since, however, *Poa pratensis* is exceedingly variable both morphologically and cytologically and since it is not a plant which lends itself well to cytological study, in the past it has been difficult to arrive at any conclusion regarding the morphological effects of the addition or elimination of one or more genoms of the germ plasm. Two lots of G.S. plants, G.S. 5 and G.S. 10, have afforded an excellent opportunity for a study of this sort. These progenies, it will be recalled, segregated into two quite clear-cut types. The tall, upright one possessed narrow leaves and closely resembled the parent, while the second type was in direct contrast to the parent morphologically. The 2n number of the first type was 49, that of the second 42.

From these data two facts are evident. First, at least two

types of *P. pratensis* can be transformed into entirely different types morphologically by the addition or elimination of one set of chromosomes. From the practical standpoint this knowledge should be of considerable importance to those interested in producing Blue grass for specific purposes. If one could predict with reasonable accuracy the types of Blue grass expected to segregate from certain selected strains, a great many of the initial difficulties encountered in strain improvement would be eliminated. Second, at least some unstable chromosomal types may revert to more stable and potentially sexual forms. Thus, the odd-numbered 49-chromosome plants which would be quite unstable upon cross-fertilization have produced 42-chromosome plants whose chromosomal stability could be maintained regardless of whether reproduction takes place by sexual or asexual methods.

On the basis of these observations the extreme diversity of *Poa pratensis* can be fairly well explained, and our knowledge of the factors affecting the behavior of the species, although still not complete, suggests a number of new approaches to the problem. The presence of a long euploid series within *P. pratensis* results in considerable variation. The various odd-chromosome forms, most of which are being maintained asexually, more than double this original variation. The complexity is further accentuated by the simultaneous operation of apomixis and sexual reproduction within single strains and the ability of unstable chromosomal types to revert to potentially sexual forms.

SUMMARY

In eleven lots of plants of *Poa pratensis* grown from seed produced by open-pollination, aberrant types amounting to from 0.09 to 18.18 per cent of the populations have been observed within strains. Although the majority of progenies contained from 1 to 5 per cent aberrants, two partially sexual strains produced 16.66 and 18.18 per cent off types. In one lot which was investigated in detail the chromosome number of the maternal-type seedlings was 49, that of the aberrants 42.

In some strains of *P. pratensis* the behavior of progenies after bagging and open-pollination is very different. Certain strains which after open-pollination produce uniform, maternal-like progenies may after bagging produce highly variable progenies which are apparently the products of gametic union. To explain this phenomenon, an hypothesis is offered based on an apomictic stimulating effect of foreign pollen.

In certain of these cultures the transition from a typical "hay" type *Poa pratensis* to a low-growing, wide-leaved spreading type of plant was brought about by the loss of one genom from the germ plasm. It is further shown that chromosome complements composed of odd-numbered chromosome sets may segregate into stable even-numbered chromosomal types.

Apomixis and the factors affecting this type of reproduction are discussed in the light of the results of this investigation. Evidence is presented which shows that apomixis is more prevalent in high polyploids than in those strains characterized by lower chromosome numbers. It is suggested that *Poa pratensis* may have originated as an alloploid, partially apomictic hybrid.

Literature Cited

Åkerberg, E. (1936). Studien über die Samenbildung bei *Poa pratensis* L. Bot. Not. **1939**: 213–280.

————, (1939). Apomictic and sexual seed formation in *Poa pratensis*. Hereditas **25**: 359–370.

Armstrong, J. M. (1937). A cytological study of the genus *Poa* L. Canadian Jour. Res. C **15**: 281–297.

Avdulow, N. P. (1931). Karyo-systematische Untersuchung der Familie Gramineen. Bull. Appl. Bot., Genet. & Pl. Breed. Suppl. 43.

Brown, W. L. (1939). Chromosome complements of five species of *Poa* with an analysis of variation in *Poa pratensis*. Amer. Jour. Bot. **26**: 717–723.

————, (1940). Variation in *Poa pratensis*. Master's thesis (unpublished), Washington University, St. Louis.

Darlington, C. D. (1937). Recent advances in cytology, 2nd. ed. 671 pp. London.

Dobzhansky, Th. (1939). Genetics and the origin of species. Columbia Univ. Press. 364 pp.

Englebert, V. (1941). The development of twin embryo sacs, embryos, and endosperm in *Poa arctica*. R. Br. Canadian Jour. Res. C **19**: 135–144.

Müntzing, A. (1933). Apomictic and sexual seed formation in *Poa*. Hereditas **17**: 131–154.

———, (1937). Polyploidy from twin seedings. Cytologia, Fujii Jubilaei Volumen. Part 1:211–227. 1937.

———, (1940). Further studies on apomixis and sexuality in *Poa*. *Ibid.* **26**: 115–190.

Tinney, F. W. (1940). Cytology of parthenogenesis in *Poa pratensis*. Jour. Agr. Res. **60**: 351–360.

———, and O. S. Aamodt. (1940). The progeny test as a measure of types of seed-development in *Poa pratensis* L. Jour. Hered. **31**: 457–464.

Explanation of Plate

PLATE 26

Selection B-1. Typical representatives of progeny resulting from open-pollination. Compare with plate 27.

BROWN—CYTOGENETICS OF POA PRATENSIS

EXPLANATION OF PLATE

PLATE 27

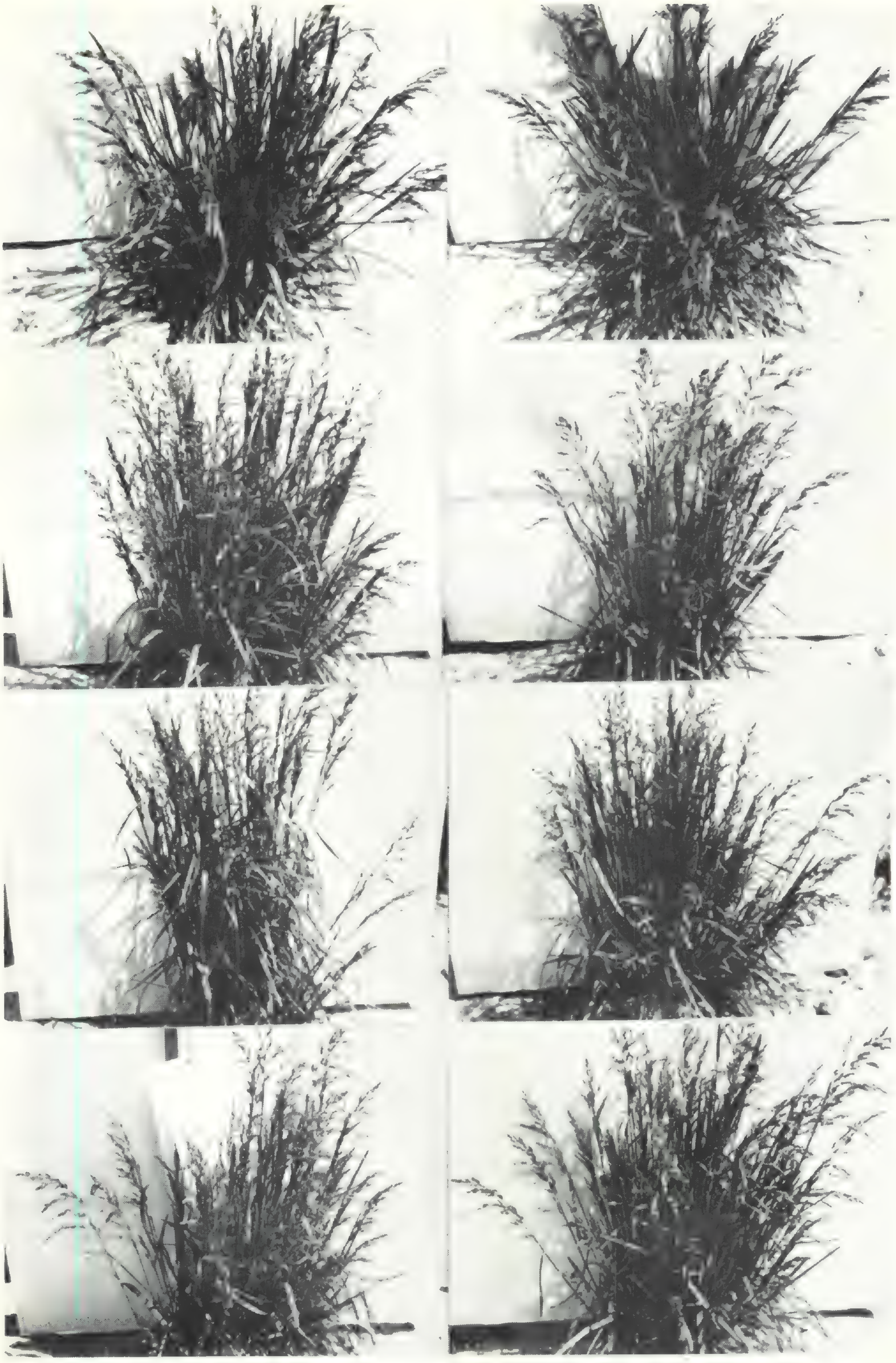
Selection B-1. Typical representatives of progeny resulting from selfing. Compare with plate 26. All plants shown in plates 26 and 27 are progeny of the same maternal parent.

BROWN—CYTOGENETICS OF POA PRATENSIS

EXPLANATION OF PLATE

PLATE 28

Selection B-6. Typical representatives of progeny resulting from open-pollination. Compare with plate 29.

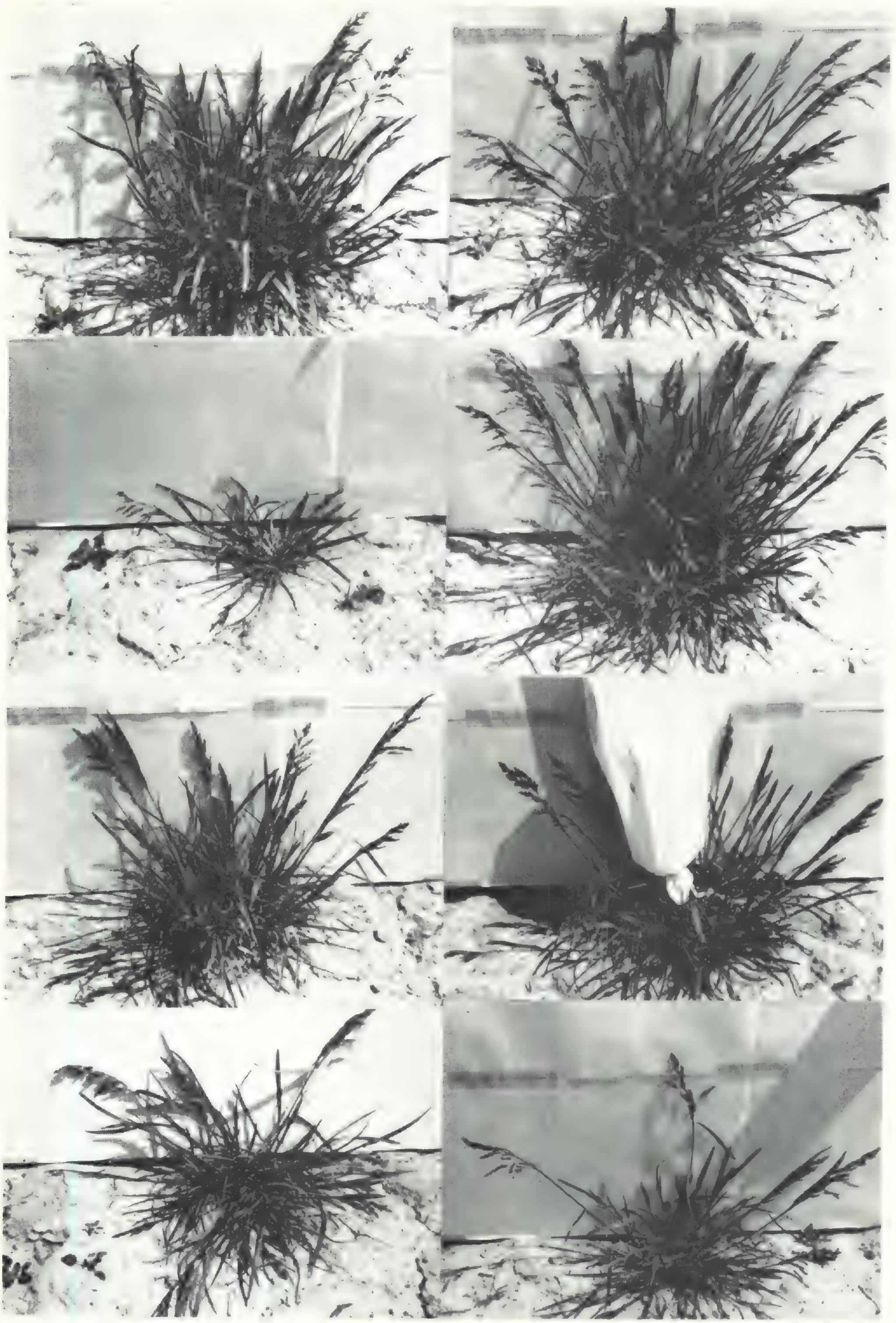


BROWN—CYTOGENETICS OF POA PRATENSIS

EXPLANATION OF PLATE

PLATE 29

Typical representatives of progeny resulting from selfing. Note the variability and low, spreading habit of these plants as compared with those shown in plate 28. All plants shown in plates 28 and 29 are progeny of the same maternal parent.



BROWN -CYTOGENETICS OF POA PRATENSIS

GENERAL INDEX TO VOLUME XXVIII

New scientific names of plants and the final members of new combinations are printed in **bold-face** type; synonyms and page numbers having reference to figures and plates, in *italics;* and previously published names and all other matter, in ordinary type.

A

Acanthaceae, Panamanian, 465
Acer saccharum, 162, 287, var. Schneckii, 162
Acerates, 204; *auriculata*, 207; *circinalis*, 207; *gomphocarpoides*, 207; *hirtella*, 207; *humilis*, 206; *Pringlei*, 206
Acerotis, 204
Aechmea **Allenii**, 411, *478*
Allen, Caroline K., Panamanian Gentianaceae determined by, 459
Allen, Paul H., Collections from Panama chiefly by, and by Robert E. Woodson Jr. and Robert W. Schery, 409
Amaryllidaceae, Panamanian, 414
Ampelamus, 208, 211; *albidus*, 211, 212; *ligulatus*, 210
Amphimixis in Poa pratensis, 511
Amphistelma, 208
Amphorella, 218; *castanea*, 232
Anantherix, 204
Anderson, Edgar. Binary variation in Tradescantia bracteata, 147; The technique and use of mass collections in plant taxonomy, 287; Hugh C. Cutler and. A preliminary survey of the genus Tripsacum, 249
Andrews, Henry N. Dichophyllum Moorei and certain associated seeds, 375; and Cortland S. Pearsall. On the flora of the Frontier formation of southwestern Wyoming, 165
Aneimia, 172; eocenica, 172
Anemia elongata, 172; Fremonti, 165, *188*, *190*, forma **fertilis**, 168, *180*, *182*, *188*, *190;* hesperia, 173, occidentalis, 173; supercretacea, 173
Anisacanthus, A revision of the North American species of the genus, 385
Anisacanthus, 385, 392; abditus, 393, *406;* *glaberrimus*, 402; Gonzalesii, 394, *406;* *Greggii*, 401; insignis, 395, *406*, *408*, var. **linearis**, 396, *408;* *junceus*, 399; pumilus, 400, *406;* *pumilus*, 395; *quadrifidus*, 393, 398, *404*, *406;* Thurberi, 396, *406;* tulensis, 401, *406;* *virgularis*, 398; Wrightii, 399, *406*, var. **brevilobus**, 400, *406*
Annonaceae, Panamanian, 427
Anthanotis, 204
Anthephora hermaphrodita, 268; pubescens, 269
Anthistiria gigantea, 268
Anthopteropsis, 441, 443; **insignis**, 441
Anthopterus, 443
Apocynaceae, Miscellaneous New Asclepiadaceae and, from tropicol America, 271; Panamanian, 461
Apomixis in Poa pratensis, 504; after first generation, 509; after open pollination, 507; after selfing, 507; chromosome numbers and, 512
Araliaceae, Panamanian, 437
Archibaccharis **panamensis**, 472
Ardisia **coclensis**, 453; **geniculata**, 454; **rigidifolia**, 455; **Scheryi**, 456; **Woodsoni**, 457
Asclepiadaceae: The North American, I, Perspective of the genera, 193; from tropical America, Miscellaneous new, 275; Panamanian, 462
Asclepiads: floral structure of, 193; Two new, from the southwestern United States, 245
Asclepias, 204, 216; subg. Acerates, 207; subg. Asclepiodolus, 207; subg. Asclepiodora, 207; *auriculata*, 207; brachystephana, 246; **circinalis**, 207; Cutleri, 246; Engelmanniana, 207; subg. Euasclepias, 206; **Fournieri**, 207; **hirtella**, 207; humilis, 206; **hypoleuca**, 206; **insignis**, 207; lanuginosa, 286; macrotis, 246; **Phenax**, 206; subg. Polyotus, 207; **Pringlei**, 206; **Ruthiae**, 245; **Scheryi**, 285; subg. Solanoa, 207; **Solanoana**, 207; **Sperryi**, 247; uncialis, 246; *villosa*, 232; **zanthodacryon**, 207
Asclepiodella, 205
Asclepiodora, 204; *circinalis*, 207; *gomphocarpoides*, 207; *insignis*, 207; *zanthodacryon*, 207

Astephanus, 208, 215; *Grisebachii*, 214; *pubescens*, 215; *utahensis*, 215
Astragalus caryocarpus, range of, 336, *360*

B

Baiera Lindleyana, 178, 377; spectabilis, 178, 377; sp. 178, *184*, *186*, 377
Balanophoraceae, Panamanian, 427
Basistelma, 208
Becklesia anomala, 178
Begoniaceae, Panamanian, 434
Beloperone, 389
Benz-pyrene, effect of, on yeast cultures, 2, 4, 14
Berry, Edward Cain. A monograph of the genus Parmelia in North America, north of Mexico, 31
Binary variation: in Tradescantia bracteata, 147; selective advantages of, 158; probable occurrence of, in other groups of organisms, 162
Biventraria, 205
Blake, S. F., Panamanian plants determined by: Compositae, 472; Polygalaceae, 432
Blakea **brunnea**, 435; **intercepta**, 435
Blepharodon, 215; *neriifolium*, 215, 244
Borreri furfuracea, 136
Bromeliaceae, Panamanian, 411
Brown, William L. The cytogenetics of Poa pratensis, 493

C

Callaeolepium, 217; *Warscewiczii*, 224
Callipteris flabellifera, 376
Camassia scilloides: Mass collections of, 293; at Meramec Highlands, 293, *298*; at New Athens, 293, *298*; variability of, 293, of inflorescences, 293, of leaves, 293, 296, of pedicel and internode length, *294*, of sepal length and width, *295*; f. Petersenii, 293
Carbon dioxide: measurement of, evolved during growth of yeast cultures, 11; volumes plotted against time, *17*, *18*
Carboniferous, plants of the, 171, 375
Carcinogens, Some effects of, on yeasts, 1: on fermentation, 11, 16; on growth, 3, 13, 19; on cell morphology, 25
Carlowrightia, 389
Castellania tropicalis, 2; effect of carcinogens on, 13
Cavendishia **Allenii**, 445; **calycina**, 447; **chiriquiensis**, 449; **gaultherioides**, 444
Celastraceae, Panamanian, 433
Cenchrus pubescens, 269
Cephaelis **chiriquensis**, 469
Ceramanthus, 216
Chileranthemum, 389
Chloris radiata, 268
Cholanthrene, effect of, on Saccharomyces ellipsoideus, 1
Chromosome studies: of Poa pratensis, 500, *503*, *505*; of Tradescantia bracteata, 160
Chthamalia, 217; *Nummularia*, 229; *pedunculata*, 230; *pubiflora*, 230
Clavija **Alleni**, 452
Clibadium **sessile**, 475
Clone; mass collections from a, 289
Coix angulatus, 254; *dactyloides*, 254
Collema exasperatum, 66
Compositae, Panamanian, 472
Coniopteris, 177; hymenophylloides, 177
Connaraceae, Panamanian, 430
Connarus **Allenii**, 430
Conostegia **chiriquensis**, 436
Contributions toward a flora of Panama, V. Collections chiefly by Paul H. Allen, and by Robert E. Woodson Jr. and Robert W. Schery, 409
Convolvulaceae, Panamanian, 463
Cornicularia pubescens, 56
Cretaceous, plants of the, 165, 172
Cross-pollination in Poa pratensis, 494
Cucurbitaceae, Panamanian, 469
Cunoniaceae, Panamanian, 429
Cutler, Hugh C. and Edgar Anderson. A preliminary survey of the genus Tripsacum, 249
Cyatheaceae-Dicksoniaceae, 176
Cyclodon, 218
Cymbopetalum **lanugipetalum**, 427
Cynanchum, 208; subg. Ampelamus, 211; *astephanoides*, 244; *carolinense*, 228; subg. Cleistolobus, 215; **cubense**, 213, *cubense*, 214; **Grisebachii**, 214; **Haughtii**, 276; *hirsutum*, 224; **jaliscanum**, 209; **jamaicense**, 210; laeve, 211; **lignosum**, 210; **ligulatum**, 210; *maritimum*, 222; subg. Mellichampia, 209; subg. Metalepis, 213; subg. Metastelma, 214; *obliquum*, 229; Palmeri, 210; *prostratum*, 230; **Rensoni**, 210; *rotatum*, 224; **saepimentorum**, 210; **sinaloense**, 210; **subpaniculatum**, 275; subg. Tylodontia, 214; **unifarium**, 210; **utahense**, 215; *villosum*, 232; *viridiflorum*, 235; **Watsonianum**, 210
Cystostemma, 216
Cytogenetics of Poa pratensis, The, 490
Cytology of yeast cultures, 25

D

Dactylodes angulatum, 254; *Dactylodes*, 254
Dactylotheca plumosa, 171; Sturi, 171
Decastelma, 208, 215
Desmopsis **glabrata**, 428
Di-benz-anthracene, effect of, on yeast cultures, 4, 14
Diceratosperma Carpenteriana, 379, 384
Dichophyllum Moorei: and certain associated seeds, 375; occurrence of, 375; restoration of, *380*
Dicliptera **gracilis**, 466, *468*
Dictyanthus, 217, 218; *aeneus*, 237; *brachistanthus*, 236; *ceratopetalus*, 236; *parviflorus*, 237; *Pavonii*, 237; *prostratus*, 236; *reticulatus*, 236; *stapeliaeflora*, 237; *tigrinus*, 237; *tuberosus*, 237; *yucatenensis*, 237
Digitaria, 252
Dioscoreaceae, Panamanian, 415
Ditassa, 208, 215
Dodge, Carroll William, Bertha Sanford Dodge, and George Thomas Johnson. Some effects of carcinogens on yeasts, 1
Dodge, Bertha Sanford, Carroll William Dodge, and George Thomas Johnson, Some effects of carcinogens on yeasts, 1
Drejera, 386; *Greggii*, 401; *juncea*, 399, 400; *puberula*, 395, 396; *Thurberi*, 396; *Wrightii*, 399
Dryopteris coloradensis, 174

E

Ecliptostelma, 243; *molle*, 243
Edisonia, 218; *pubiflora*, 230
Elionurus tripsacoides, 268
Enslenia, 208, *albida*, 211, 212; *jamaicensis*, 210; *ligulata*, 210
Enslinia, 208
Epicion, 208
Epidendrum **Allenii**, 418, *484;* **ellipsophyllum**, 419 *484;* **gibbosum**, 420, *482;* **pendens**, 421, *486;* ramosum var. **angustifolium**, 422
Epling, C. C., Panamanian Labiatae determined by, 464
Equisetaceae, 178
Equisetum sp., 178, *182*
Erickson, Ralph O. Mass collections: Camassia scilloides, 293
Eriocaulaceae, Panamanian, 411
Evernia americana, 136, 137; *furfuracea* var. *Cladonia*, 139; *kamtschadalis*, 136, 137
Exolobus, 238; *albomarginatus*, 242

F

Faramea **Woodsonii**, 470
Fassett, Norman C. Mass collections: Rubus odoratus and R. parviflorus, 299
Fermentation of Saccharomyces ellipsoideus, measurement of, 11, 16, *17*, *19*, *20*
Fernald's "varieties" of Rubus parviflorus, 317, 322
Ferns, fossil, 165, 375
Fimbristemma, 238; *calycosa*, 243, 284; *stenosepola*, 243, 284, *Warscewiczii*, 224
Fischeria, 237; *aristolochiaefolia*, 242; viridis, 238
Flora of the Frontier formation of southwestern Wyoming, On the, 165
Floral anatomy of Asclepiads, 193
Fossil flora: of the Frontier formation of southwestern Wyoming, 165; of Kansas, 375
Frontier formation of southwestern Wyoming: On the flora of the, 165; relation of, to other cretaceous formations, 167
Funastrum, 216; *Torreyi*, 217

G

Gentianaceae, Panamanian, 459
Geography: correlation of variations in Rubus odoratus with, 303, in R. parviflorus with, 332
Geology: correlation between characters of Rubus odoratus and R. parviflorus and, 303; of the Frontier formation of southwestern Wyoming, 166
Gesneriaceae, Panamanian, 465
Ginkgo, 377; *biloba*, 378
Glaciation in relation to occurrence of Rubus odoratus, 308, of R. parviflorus, 332
Gleason, H. A., Panamanian Melastomaceae determined by, 434
Gleicheniaceae, 174
Gleichenia pectinata, 174
Gleichenites **coloradensis**, 174, *184*, *186*, *192;* Gieseckiana, 175
Glockeria **reflexiflora**, 465, *466*
Glucose, loss of, during growth of yeast cultures, 12, 18
Gomphocarpus, 205; *hypoleucus*, 206; *purpurascens*, 207
Gonolobus, 238; *acuminatus*, 231; **albomarginatus**, 242; *altatensis*, 236; *araneosus*, 222; **aristolochiaefolius**, 242; **arizonicus**, 243; *atratus*, 233; *Baldwynianus*, 228; *bayatensis*, 226;

bicolor, 236; *bifidus*, 230; *biflorus*, 228; *calcicola*, 224; *californicus*, 230; **calycosus**, 242, 284; *carolinensis*, 228; *caudatus*, 233; **chiapensis**, 242; *chihuahuensis*, 232; chiriquensis, 462; *chrysanthus*, 222; *congestus*, 224; **cteniophorus**, 243, 283; *cynanchoides*, 228; **dasystephanus**, 243; *decipiens*, 228; *diadematus*, 225; *Ekmanii*, 226; subg. Eugonolobus, 242; *flavidulus*, 228; *floccosus*, 222; **fuscoviolaceus**, 462; *gonocarpus*, 212; **gonoloboides**, 243; *guatemalensis*, 235; *hastulatus*, 230; *hirsutus*, var. *flavidulus*, 228; *inconspicuus*, 222; *laevis*, 211; *lanceolatus*, 234; **lanugiflorus**, 282; **Lasiostemma**, 243; **longipetiolatus**, 282; Lundellii, 283; *macrophyllus*, 212; *magnifolius*, 225; *maritimus*, 222; *nigrescens*, 233; *nipensis*, 226; *obliquus*, 229, var. *Shortii*, 231; **oblongifolius**, 243; *parviflorus*, 229, var. *brevicoronatus*, 228; *parvifolius*, 230; *patalensis*, 223; *pauciflorus*, 226; *petiolaris*, 223; *picturatus*, 233; *pilosus*, 233; *pogonanthus*, 232; *productus*, 230; *prostratus*, 230; *pseudobarbatus*, 235; subg. Pseudolachnostoma, 243; subg. Pterolobus, 242; *publiflorus*, 230; *Purpusii*, 223; *reticulatus*, 234; *Schaffneri*, 230; *Shortii*, 231; *Sintenisii*, 226; **stenanthus**, 243; *stenopetalus*, 231; **stenosepalus**, 243, 284; **Steyermarkii**, 283; *suberiferus*, 233; *suberosus*, 212, 222; *tigrinus*, 226; *Tuerckheimii*, 234; *unifarius*, 210; *variifolius*, 226; *velutinus*, 234, var. *calycinus*, 235; *viridiflorus*, 235

Gonolobus, 218

Grass: Kentucky blue, 493; Tripsacum, 249

Great Plains environment, relation of, to variability in Tradescantia, 158

Growth studies of yeast cultures, 3

H

Hackelochloa granularis, 268

Haemacytometer use of, in counting yeast cells, 7, 19

Hagen, Stanley Harlan. A revision of the North American species of the genus Anisacanthus, 385

Halenia **euryphylla**, 459

Heliostemma, 218

Hemarthria compressa, 268

Herbarium studies, use of mass collections in, 287, *290*

Himantostemma, 217; *Pringlei*, 223

Hoffmannia **Woodsonii**, 471

Hostea, 217

Hybridization in Tradescantia, 153

Hypogymnia enteromorpha, 50

I

Ibatia, 217; *maritima*, 223; *mollis*, 223; *muricata*, 223

Illinois bottom-lands, Camassias growing in, 293, 296, *298*

Imbricaria, 42; *centrifuga*, 68; *conspersa*, 72, *f. isidiata*, 76; *crinita*, 127; *diatrypa*, 43, 44; *dubia*, 90; *encausta*, 53; *enteromorpha*, 50; *incurvus*, 67; *olivacea*, 60; *physodes*, 46; *quercina*, 91; *stygia*, 57

Ipomoea **mucronata**, 463

Irmischia, 208

Ischaemum aristatum, 268; *glabrum*, 254; muticum, 269; rugosum, 268

J

Jacobinia, 389

Johnson, George Thomas, Carroll William Dodge, and. Some effects of carcinogens on yeasts, 1

Jurassic rocks, plants of, 172

Justicia, 385; *coccinea*, 398, *404*; *pumila*, 401; *quadrifida*, 398; *superba*, 398, 401; *virgularis*, 398, *404*

K

Klukia, 172

L

Labiatae, Panamanian, 464

Labidostelma, 218; *guatemalense*, 224, 281

Lachnostoma, 238; *arizonicum*, 243; *Balbisii*, 232; *gonoloboides*, 243; *Lasiostemma*, 243; *maritimum*, 223; *molle*, 223; *parviflorum*, 229; *prostratum*, 230

Leonard, E. C., Panamanian Acanthaceae determined by, 465

Lichen aspidotus, 63; *Borreri*, 88; *caperatus*, 113, 114; *centrifugus*, 68, 72; *conspersus*, 72; *diatrypus*, 43, 44; *dubius*, 90; *encaustus*, 53, 54; *furfuraceus*, 137, 138; *incurvus*, 67; *intestinalis*, 50; *laciniatus* var. *physodes*, 45; *laevigatus*, 109; *lanatus*, 56; *olivaceus*, 59; *omphalodes*, 80; *perforatus*, 130; *perlatus*, 122; *pertusus*,

43, 44; *physodes*, 45; *pubescens*, 56; *quercinus*, 91, 92; *saxatilis*, 82; *scorteus*, 92; *stygius*, 57; *tiliaceus*, 91
Lichenoides furfuraceum, 137, 138
Liliaceae, Panamanian, 414
Loasaceae, Panamanian, 433
Lobaria furfuracea, 137, 138; *incurva*, 67; *olivacea*, 59; *perlata*, 122, var. *ciliata*, 124; *physodes*, 46; *saxatilis*, 82; *stygia*, 57; *terebrata*, 43; *tiliacea*, 91
Loranthaceae, Panamanian, 426
Lundell, C. L., Panamanian plants determined by: Celastraceae, 433; Myrsinaceae, 453; Rutaceae, 431; Theophrastaceae, 452
Lycopodiaceae, 409
Lygonium, 171
Lyonia, 208

M

Macleania, 443; **epiphytica**, 439
Macroscepis, 217, 218; *congestiflora*, 224; *obovata*, 225
Macrozamia heteromera, 179
Maguire, Bassett, and Robert E. Woodson, Jr. Two new Asclepiads from the southwestern United States, 245
Maiscillo, 265
Maize, North American, 249
Malouetia **Cuatrecasatis**, 274; lata, 275
Mandevilla **jasminiflora**, 273; lancifolia, 274; **nerioides**, 274; Syrinx, 274
Manisuris cylindrica, 252, 268
Marantaceae, Panamanian, 415
Marsdenia, 201, 243; **astephanoides**, 244; *bicolor*, 236; Gilgiana, 244; **nerifolia**, 244; **pseudo-edulis**, 284; **Steyermarkii**, 285
Mass collections: The technique and use of, in plant taxonomy, 287; Camassia scilloides, 293; Rubus odoratus and R. parviflorus, 299; Tradescantia bracteata, 149
Matelea, 204, 217; **acuminata**, 225, 231; **adenocardium**, 227; **alabamensis**, 234; **altatensis**, 236; subg. Amphorella, 232; **araneosus**, 222; **atrocoronata**, 222; **Balbisii**, 231; **Baldwyniana**, 227; **bayatensis**, 226; **belizensis**, 232; **bicolor**, 236; **biflora**, 228; **brevicoronata**, 228; **calcarata**, 232; **calcicola**, 224; **campechiana**, 234; **camporum**, 228; **caroliniensis**, 228; **castanea**, 232; **caudata**, 233, 277; **ceratopetala**, 236; **chihuahuensis**, 232; **chrysantha**, 222; subg. Chthamalia, 227; **congesta**, 224; **congestiflora**, 224; **cordata**, 236; **cordifolia**, 222; **crassifolia**, 236; **crenata**, 233; **cyclophylla**, 233; **cynanchiflora**, 278; **cynanchoides**, 228; **Decasnei**, 232; **decipiens**, 228; **diademata**, 225; **dictyantha**, 236; subg. Dictyanthus, 236, 281; **diffusa**, 236; **Ekmanii**, 226; subg. Eumatelea, 234, 278; **flavidula**, 228; **floridana**, 229; **fruticosa**, 222; **Gentlei**, 234; **glaberrima**, 281; **gonoloboides**, 222; **grandiflora**, 235; **Greggii**, 229; **guatemalensis**, 235; subg. Heliostemma, 233, 276; **Hemsleyana**, 237; **Hintoniana**, 280; subg. Ibatia, 222, 281; **inconspicua**, 222; **inops**, 276; subg. Labidostelma, 224, 280; **lanata**, 225; **lanceolata**, 234; **leptogenia**, 232; **Le Sueurii**, 229; subg. Macroscepis, 224; **magnifolia**, 225; **maritima**, 222; **megacarpha**, 236; subg. Microdactylon, 236; **mollis**, 223; **nigrescens**, 233; **nipensis**, 226; **Nummularia**, 229; **obliqua**, 229; **oblongata**, 226; **obovata**, 225; **ovatifolia**, 225; subg. Pachystelma, 236; **parviflora**, 229; **parvifolia**, 230; **patalensis**, 223; **pauciflora**, 226; **Pavonii**, 237; **pedunculata**, 230; **petiolaris**, 223; subg. Pherotrichis, 231; **picturata**, 233, 277; **pilosa**, 233; **pinguifolia**, 235; **Pittieri**, 234, 277; subg. Poicilla, 225; subg. Polystemma, 232; **porphyrantha**, 223; **Pringlei**, 223; **producta**, 230; **Prosthecidiscus**, 223; **prostrata**, 230; **pseudobarbata**, 235; subg. Ptycanthera, 225; **pubiflora**, 230; **pueblensis**, 223; **Purpusii**, 223; **Quirosii**, 224, 281; **reticulata**, 234; **rupestris**, 232; **Schaffneri**, 230; **scopulorum**, 232; **Shortii**, 231; **Sintenisii**, 226; **Standleyana**, 237; **stapeliaeflora**, 237; **stenopetala**, 231; **Steyermarkii**, 278; **tamnifolia**, 225; **tenuis**, 279; subg. Tiarastemma, 232; **tigrina**, 226; **tinctoria**, 277; subg. Trichosacme, 225; **tristiflora**, 223; **tuberosa**, 237; **Tuerckheimii**, 234; **umbellata**, 223; **Vailiana**, 231; **varifolia**, 226; **velutina**, 234; **violacea**, 280; **viridiflora**, 235; **Warscewiczii**, 224; **Wootonii**, 231; **yucatanensis**, 237
Maxillaria **Biolleyi**, 425; **Bradeorum**, 425; **fulgens**, 425; **umbratilis**, 425
Maxon, W. R., Panamanian plants determined by: Lycopodiaceae, 409; Polypodiaceae, 409
Media used in growing yeasts, 3

Meiosis in Poa pratensis, 502
Melastomaceae, Panamanian, 434
Mellichampia, 208; *ligulata*, 210; *rubescens*, 210; *sinaloensis*, 210
Menegazzia, 43; *physodes*, 46
Meramec Highlands, Mo., mass collections of Camassia scilloides from, 293, *298*
Meriania **panamensis**, 436
Metalepsis, 208; *cubensis*, 213, 214, 275
Metastelma, 208, 214
Methyl cholanthrene, effect of, on yeast cultures, 2, 4, 14, 18
Microdactylon, 218; *cordatum*, 236
Microorganisms, measurements of growth of, 5
Microstelma, 204
Microtaenia, 176; paucifolia, 165, 176, *182*; variabilis, 176, 177, *182*
Miscellaneous new Asclepiadaceae and Apocynaceae from tropical America, 271
Moldenke, H. N., Panamanian plants determined by: Eriocaulaceae, 411; Verbenaceae, 464
Monograph of the genus Parmelia in North America, north of Mexico, 31
Morton, C. V., Panamanian plants determined by: Dioscoreaceae, 415; Gesneriaceae, 465; Solanaceae, 464
Mycocandida onychophila, 2; effect of carcinogens on, 13
Myrsinaceae, Panamanian, 453

N

Nanaturis, 208
Nephradenia, 243; *fruticosa*, 244; *nerifolia*, 244
New Athens, Ill., mass collections of Camassia scilloides from, 293, *298*
North American Asclepiadaceae, I. Perspective of the genera, 193
Nunataks, survival of thimbleberry on, 299, 332, 345

O

Odontonema, 389, 402
Odontostephana, 218; *Baldwiniana*, 228; *carolinensis*, 228; *decipiens*, 228; *flavidula*, 229; *floridana*, 229; *obliqua*, 229; *Shortii*, 231
Oligoron, 204
Onistis, 204
Open-pollination in Poa pratensis, 497; apomixis after, 507
Orchidaceae, Panamanian, 415
Orthosia, 208; *acuminata*, 225; *oblongata*, 226
Otanema, 204
Otaria, 204
Oxalidaceae, Panamanian, 431
Oxalis **coccinea**, 431
Oxypetalum, 208; cordifolia, 208
Oxypteryx, 205
Ozarks: Camassias growing in, 293, 296, *298*

P

Pachystelma, 218; *cordatum*, 236
Palmorchis **trilobulata**, 415, *480*
Panama, Contributions toward a flora of, V. Collections chiefly by Paul H. Allen, Robert E. Woodson, Jr. and Robert W. Schery, 409
Parathesis **Woodsoni**, 458
Parmelia, A monograph of the genus, in North America, north of Mexico, 31: chemical reactions, 38; ecology, 32; history, 31; morphology, 34; taxonomy, 41
Parmelia, 41; acanthifolia, 79; *ambigua*, 141, var. *Halei*, 141; *americana*, 136, 137; Amphigymnia (Euparmelia sect.), 112; *Amphigymnia* (sect.), 112; *arizonica*, 141; *aspidota*, 63; atrofusca, 141; aurulenta, 110; Bolliana, 90; Borreri, 88; *Borreri* var. *hypomela*, 88, var. *rudecta*, 96; *camtschadalis* f. *americana*, 136, 137; *Canalicularia* (sect.), 135; caperata, 113, var. **incorrupta**, 118, var. subglauca, 119; caroliniana, 106; centrifuga, 68; *ceratophylla* var. *phyllodes*, 46; cetrarioides, 125, var. rubescens, 127; cetrata, 100, var. subisidiosa, 101; chlorochroa, 70; *ciliata*, 124; cirrhata, 136; Cladonia, 139; *colpodes*, 141; conspersa, 72, var. **isidiata**, 76; *conspersa* f. *isidiata*, 76; conspurcata, 65; *cribellata*, 52, 53; crinita, 127; cristifera, 129; cubensis, 108; *dubia*, 90; encausta, 53; endoleuca, 67; endoxantha, 110; enteromorpha, 50; erecta, 103; Euparmelia (subgen.), 55; *Euparmelia* (subgen.), 42; *Everniaeformes* (Euparmelia sect.), 135, 136, 141; *Everniiformes* (subgen.), 135; *Everniiformes* (sect.), 135; exasperata, 66; Finkii, 106; *flavicans*, 121; Frankliniana, 141; *frondifera*, 132; furfuracea, 137; *Halseyana*, 141; Herreana, 121; Herrei, 88; *horrescens*, 85; **Hubrichtii**, 102; Hypogymnia (subgen.), 45; Hypotrachyna (Euparmelia sect.), 79; *Hypotrachyna* (sect.), 79; *Imbricaria* (sect.),

42; *incorrupta*, 118; incurva, 67; laevigata, 109; latissima, 134; *leiocarpa*, 96; leucochlora, 78; **lineola**, 77; livida, 105; *Lobaria* (sect.), 42; *Lobaria* sect. *Imbricaria*, 42; lophyrea, 52; margaritata, 141; Melanoparmelia (Euparmelia sect.), 55; *Melanoparmelia* (sect.), 55; Menegazzia (subgen.), 42; *Michauxiana*, 124; molliuscula, 71; multispora, 64; *Nepalensis*, 136, 137; olivacea, 59, var. aspidota, 63, var. **glabra**, 64; *olivacea* var. *corticola* f. *conspurcata*, 65; *olivacea* corticola* var. *glabra*, 64, var. *multispora*, 64, var. *polyspora*, 64, var. *prolixa*, 58; *olivaria* f. *cetrarioides*, 125; omphalodes, 80; perforata, 130, var. hypotropa, 132; perlata, 122, var. ciliata, 124; *perlata* var. *flavicans*, 121, f. *rubescens*, 127; pertusa, 43; physodes, 45, var. labrosa, 49, var. obscura, 49, var. platyphylla, 49, var. vittata, 49; *physodes* var. *encausta*, 53, var. *enteromorpha*, 50, var. *vulgaris*, 46; praesignis, 119; *praetervisa*, 133; proboscidea, 132; prolixa, 58; **Pseudevernia** (subgen.), 135; pubescens, 56; quercina, 91; reticulata, 99; rudecta, 96; *rudiata*, 96; saxatilis, 82, var. Anzi, 85; *saxatilis* var. *leucochroa*, 82, var. *omphalodes*, 80; *sinuosa* var. *laevigata*, 109; soredica, 120; sphaerosporella, 71; *stuppea*, 141; stygia, 57; *subglauca*, 119; sublaevigata, 107; sublinearis, 79; *submarginalis*, 124; *subolivacea*, 60; sulcata, 86; sulphurosa, 112; texana, 95; *tiliacea*, 91, var. *sublaevigata*, 107, var. *sulphurosa*, 112; tinctoria, 133; vagans, 71; villosa, 135; Xanthoparmelia (Euparmelia sect.), 66; *Xanthoparmelia* (sect.), 67
Parmotrema, 112, 113
Partula suturalis, progressive variation in, 308; map showing, *352*
Pattalias, 208; *Palmeri*, 210
Pearsall, Cortland S., Henry N. Andrews and. On the flora of the Frontier formation of southwestern Wyoming, 165
Pentagonium, 216
Peperomia **Scheryi**, 426
Peptone, growth of yeasts on, 3
Pherotrichis, 217; *Balbisii*, 232; *leptogenia*, 232; *Schaffneri*, 232
Philibertia, 216; *tomentella*, 217; *Torreyi*, 217
Philibertella, 216; *Torreyi*, 217
Physcia, 42
Piper **fagopyricarpum**, 426
Piperaceae, Panamanian, 426
Platisma caperatum, 113, 114; *perforatum*, 130
Pleurothallis **macrantha**, 417, *482*
Poa pratensis, The cytogenetics of, 493: apomixis in, 504; chromosomes of, 500, *503*, *505*; genetics of various genoms, 513; progeny of, 494, resulting from open-pollination, 497, *516*, *520*, from selfing, 497 *518*, *522*; variation in, 496, 498
Podocarpus **Allenii**, 409
Podostemma, 205
Podostigma, 204
Pogonatherum saccharoideum, 269
Poicilla, 217; *acuminata*, 226; *oblongata*, 226; *ovatifolia*, 225; *tamnifolia*, 225
Poicillopsis, 218; *acuminata*, 226; *oblongata*, 226
Pollination in Poa pratensis, 497
Polygalaceae, Panamanian, 432
Polyotus, 204
Polypodiaceae, 174; Panamanian, 409
Polystemma, 217; *rupestre*, 232; *scopulorum*, 233; *viridiflora*, 232
Polytoca semiteres, 269
Prairie environment, relation of variation in Tradescantia bracteata to, 158
Preglacial relic, Rubus parviflorus as a, 299, 332
Prosthecidiscus, 218; *Berterii*, 225; *guatemalensis*, 223
Psammisia, 443, **panamensis**, 440
Pseudevernia, 135, 141; *furfuracea*, 138
Psittacanthus **Scheryi**, 426
Psygmophyllum, 377; cuneifolium, 378; Kidstoni, 378; Grosserti, 378
Ptycanthera, 217
Ptychanthera Berterii, 225, 226; *mollis*, 223; *oblongata*, 226; *ovatifolia*, 225

Q

Quadricasaea, 271; **caquetensis**, 272; **inaequilateralis**, 272

R

Rauwolfia **sarapiquensis**, 271
Revision of the North American species of the genus Anisacanthus, 385
Rothrockia, 217; *cordifolia*, 222; *fruticosa*, 222; *umbellata*, 223
Rottboellia hirsuta, 268, 269; Myurus, 269
Roulinia, 208; *ligulata*, 210; *Palmeri*, 210; *Rensoni*, 210; *sinaloensis*, 210; *unifaria*, 210

Rouliniella, 208, 211; *jaliscana*, 209; *jamaicensis*, 210; *lignosa*, 210; *Palmeri*, 210; *unifaria*, 210
Rubiaceae, Panamanian, 469
Rubus, 299; columbianus, 302; § Eubatus, 321; idaeus, 308; *nutkanus* β *Nuttallii*, 323, var. *parvifolius*, 323, var. *scopulorum*, 323; odoratus, 300; parviflorus, 314; strigosus, 308
Rubus odoratus: geographic occurrence of forms in mass collections, 303; variation in, 300, correlation of, with geography, 306, kinds of, 300; taxonomy of intraspecific, 302; f. **bifarius**, 302; var. columbianus, 302; f. **glabrifolius**, 302; f. **heteradenius**, 302; f. **hypomalacus**, 302; var. *malachophyllus*, 302; f. **paraheteradenius**, 303; f. **parahypomalacus**, 303; f. **scopulorum**, 302
Rubus odoratus and R. parviflorus; mass collections of, 299; maps showing locations of, *347–367*; habitats of, *368–374*
Rubus parviflorus: aggressiveness of, 336; forms of, 322, in mass collections, 327; kinds of variation, 314; "varieties" of, 317; f. **acephalus**, 325; f. **adenius**, 324; f. **allocalyx**, 324; f. **bifarius**, 323; var. *bifarius*, 318, 323; var. *genuinus*, 317, 324; var. grandiflorus, 318, 323; var. **glabrifolius**, 328; f. **heteradenius**, 323; var. *heteradenius*, 318, 323; f. **hypomalacus**, 318; var. *hypomalacus*, 318, 323; f. **micradenius**, 324; f. **Nuttallii**, 323; var. *parvifolius*, 319, 323; f. **scopulorum**, 323; var. *scopulorum*, 319, 323; f. **trichophorus**, 324; var. velutinus, 318, 324, 325, f. **isohypomalacus**, 325, f. **parahypomalacus**, 325, f. **paramicradenius**, 326, f. **paratrichophorus**, 325, f. **parbifarius**, 325, f. **parvillosus**, 325, f. **praebifarius**, 325; f. **villosus**, 324
Ruffordia Goepperti, 173
Rutaceae, Panamanian, 431
Rytidoloma, 217; *reticulata*, 236

S

Sacaton, 265
Saccharomyces ellipsoideus, effect of carcinogens on, 1; cell *differentiation* of, 25; fermentation of, 11, 16; growth of, 3, 13; morphology of, 2; population studies, 19
Samaropsis, 379
Sarcostemma, 216; **tomentella**, 217; **Torreyi**, 217
Satyria **Allenii**, 451
Scaphyglottis **Lindeniana**, 423; **tenella**, 423, *488*
Schefflera **epiphytica**, 437
Schery, Robert W., Robert E. Woodson, Jr. and. Contributions toward a flora of Panama, V. Collections chiefly by Paul H. Allen and by Robert E. Woodson, Jr. and Robert W. Schery, 409
Schizaea, 171; elegans, 172
Schizaeaceae, 168; fossil history of the, 171
Schizaeopsis expansa, 172
Schizaeopteris mezozoica, 172
Schizonotus, 205; *purpurascens*, 207
Schubert, B. G., L. B. Smith and. Panamanian Begoniaceae determined by, 434
Seeds, Dichoplyllum Moorei and certain associated, 375, 379
Selfing in Poa pratensis, 497, *518*, *522*; apomixis after, 507
Senftenbergia pinnaeformis, 171; Sturi, 171
Seutera, 208
Smith, A. C., Panama plants determined by: Araliaceae, 437; Vacciniaceae, 438
Smith, L. B., Panamanian Bromeliaceae determined by, 411; and B. G. Schubert, Panamanian Begoniaceae determined by, 411
Solanaceae, Panamanian, 464
Solanoa, 205; *purpurascens*, 207
Solanoana, 205; *purpurascens*, 207
Southwestern United States, Two new Asclepiads from the, 245
Squamaria stygia, 57
Standley, P. C., Panamanian plants determined by: Rubiaceae, 469; Taxaceae, 409
Stelmagonum, 204
Stemmadenia **Allenii**, 461
Steyermark, J. A., Panamanian plants determined by: Connaraceae, 430; Gentianaceae, 460
Stylandra, 204
Sugar, loss of, during growth of yeast cultures, 12

T

Tainionema, 208
Tassadia, 208
Taxaceae, Panamanian, 409
Taxonomy: plant, The technique and use of mass collections in, 287; of intraspecific variation in Rubus odoratus and R. parviflorus, 302

Tetracustelma, 217; *prostrata*, 230
Theophrastaceae, Panamanian, 452
Thibaudia, 443
Thimbleberry: habitats of, 299, *368–374;* mass collections of, 299; occurrence on nunataks, 299, 332, 345; ranges of, 303, *347 367*; variation in, 299, 306, 314
Trachys mucronata, 269
Tradescantia bracteata: Binary variation in, 147; cytology of, 160; mass collections of, 150; type A, 147, *148;* type B, 148, *149;* hirsutiflora, 151; virginiana, 147, 151
Trelease, William, Panamanian Piperaceae determined by, 426
Trichosacme, 217; *lanata*, 225
Trichostelma, 238; *ciliatum*, 242, 284; *oblongifolium*, 243
Tripsacum, A preliminary survey of the genus, 249
Tripsacum, 252; *acutiflorum*, 260; *aegilopoides*, 268; *aristatum*, 268; **australe**, 253, 259; *avenacea*, 268; *ciliare*, 268; *compressum*, 254, 268; *cylindricum*, 268; dactyloides, 253, 254, var. **occidentale**, 258; *dactyloides* var. *angustifolium*, 260, *floridanum*, 252; subsp. *hispidum*, 259, 260, var. *Lemmoni*, 260, var. *monostachyon*, 254, var. *monostachyum*, 254; *distachyum*, 268; *distichum*, 268; fasciculatum, 253, 264; *fasciculatum*, 264, 268; floridanum, 252, 253, *giganteum*, 268; *granulare*, 268; *hermaphroditum*, 268; *hirsutum*, 269; lanceolatum, 253, 260; *lanceolatum*, 260; latifolium, 253, 267; *laxa*, 269; *laxum*, 264; *Lemmoni*, 260; *monostachyum*, 254; *mucronatum*, 269; *muticum*, 269; *myuros*, 269; *paniceum*, 269; pilosum, 253, 265; *pubescens*, 269; *semiteres*, 269
Tristachya avenacea, 268; laxa, 269
Tropical America, Miscellaneous new Asclepiadaceae and Apocynaceae from, 271
Tylodontia, 208; *cubensis*, 214
Tympananthe, 217; *suberosa*, 237

U

Urostephanus, 217; *gonoloboides*, 222

V

Vacciniaceae, Panamanian, 438
Variation: binary, in Tradescantia bracteata, 147; in Poa pratensis, 493; use of mass collections in study of, 150, 287; in Camassia scilloides, 293; in Rubus odoratus, 300, and R. parviflorus, 314, correlation of, with geography, 306, relation of, to environment, 158, 296; taxonomy of intraspecific, 302
Verbenaceae, Panamanian, 464
Vincetoxicum, 218, 238; *acuminatum*, 231; *adenocardium*, 227; *alabamense*, 234; *astephanoides*, 244; *atrocoronatum*, 222; *Baldwinianum*, 228; *belizense*, 232; *biflorum*, 228; *calcaratum*, 232; *calcicola*, 224; *campechianum*, 234; *camporum*, 228; *carolinense*, 228; *caudatum*, 233; *chiapense*, 242; *chihuahuense*, 232; *chiriquense*, 280; *chrysanthum*, 222; *congestum*, 224; *crassifolium*, 236; *crenatum*, 233; *cteniophorum*, 243; *cyclophyllum*, 233; *cynanchoides*, 228; *dasystephanum*, 243; *diadematum*, 225; *discolor*, 234; *flavidulum*, 229; *floridanum*, 229; *Gentlei*, 234; *grandiflorum*, 235; *Grayanum*, 233; *Greggii*, 229; *hastulatum*, 230; *LeSueurii*, 229; *Lundellii*, 243; *magnifolium*, 225; *megacarphum*, 236; *nigrescens*, 233; *obliquum*, 229; *parviflorum*, 230; *petiolare*, 223; *pilosum*, 234; *pinguifolium*, 235; *Pittieri*, 234; *porphyranthum*, 223; *productum*, 230; *pubiflorum*, 230; *pueblensis*, 223; *quercetorum*, 234; *Quirosii*, 224; *reticulatum*, 234; *saepimentorum*, 210; *Shortii*, 231; *Sintenisii*, 226; *stenanthum*, 243; *stenopetalum*, 231; *stenophyllum*, 234; *suberiferum*, 234; *tortum*, 243; *trichoneuron*, 234; *tristiflorum*, 223; *variifolium*, 226; *velutinum*, 235; *viridiflorum*, 235; *Wootonii*, 231
Vitaceae, Panamanian, 433
Voyria **Allenii**, 460

W

Weinmannia **pseudolaurina**, 429
Williams, L. O., Panamanian Orchidaceae determined by, 415
Woodson, Robert E., Jr. Miscellaneous new Asclepiadaceae and Apocynaceae from tropical America, 271; The North American Asclepiadaceae. I. Perspective of the genera, 193; and Bassett Maguire. Two new Asclepiads from the southwestern United States, 245; and Robert W. Schery. Contributions toward a flora of Panama. V, Collections chiefly by Paul H. Allen and by Robert E. Woodson, Jr. and Robert W. Schery, 409

Wyoming, southwestern, On the flora of the frontier formation of, 165

Y

Yeast cultures: cell differentiation in, 25; effect of various carcinogens on, 14; fermentation of, 11, 17, *17–20;* growth of, 3, 13, *14, 16;* population studies, 19, *21, 22*

Yeasts, Some effects of carcinogens on, 1

Z

Zanthoxylum **Scheryi**, 431
Zea, 249
Zosima, 216
Zygopetalum **parviflorum**, 424, *490*
Zymonema capsulatus, 2; dermatitidis, 2, effect of carcinogens on, 13

Volume XXVIII Number 1

Annals
of the
Missouri Botanical
Garden

FEBRUARY, 1941

Some Effects of Carcinogens on Yeasts.....
Carroll W. Dodge, Bertha S. Dodge and George Thomas Johnson 1- 30

A Monograph of the Genus Parmelia in North America, North of Mexico.....Edward C. Berry 31-146

PUBLISHED QUARTERLY AT FULTON, MISSOURI,
BY THE BOARD OF TRUSTEES OF THE MISSOURI BOTANICAL GARDEN,
ST. LOUIS, MISSOURI.

Entered as second-class matter at the post-office at Fulton, Missouri,
under the Act of March 3, 1879.

Annals

of the

Missouri Botanical Garden

A Quarterly Journal Containing Scientific Contributions from the Missouri Botanical Garden and the Henry Shaw School of Botany of Washington University in affiliation with the Missouri Botanical Garden.

Information

The ANNALS OF THE MISSOURI BOTANICAL GARDEN appears four times during the calendar year: February, April, September, and November. Four numbers constitute a volume.

Subscription Price.....$6.00 per volume
Single Numbers..... 1.50 each*

Contents of previous issues of the ANNALS OF THE MISSOURI BOTANICAL GARDEN are listed in the Agricultural Index, published by the H. W. Wilson Company.

*Except No. 3 of Vol. 22, price $5.00, and No. 2 of Vol. 25, price $2.50.

STAFF
OF THE MISSOURI BOTANICAL GARDEN

Director
GEORGE T. MOORE

HERMANN VON SCHRENK,
Pathologist

JESSE M. GREENMAN,
Curator of the Herbarium

CARROLL W. DODGE,
Mycologist

EDGAR ANDERSON,
Geneticist

ROBERT E. WOODSON, JR.
Assistant Curator of the Herbarium

NELL C. HORNER,
Librarian and Editor of Publications

BOARD OF TRUSTEES
OF THE MISSOURI BOTANICAL GARDEN

President
GEORGE C. HITCHCOCK

Vice-President
DANIEL K. CATLIN

Second Vice-President
EUGENE PETTUS

L. RAY CARTER
DUDLEY FRENCH
JOHN S. LEHMANN
GEORGE T. MOORE
A. WESSEL SHAPLEIGH
ETHAN A. H. SHEPLEY

EX-OFFICIO MEMBERS

GEORGE R. THROOP,
Chancellor of Washington University

WILLIAM SCARLETT,
Bishop of the Diocese of Missouri

BERNARD F. DICKMANN,
Mayor of the City of St. Louis

A. H. TIMMERMAN,
President of the Academy of Science of St. Louis

MAX G. BARON,
President of the Board of Education of St. Louis

GERALD ULRICI, *Secretary*